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ABSTRACT

After identifying the components of a community college financial system as enrollment, costs, revenues and tuition, this paper addresses the need for a system dynamics analysis of a California community college district. This systems approach would assess the possible effects of alternative policies on the characteristic behavior modes of the interrelated district components and construct a simple but complete system dynamics model to facilitate the assessment. Building the finance simulation model involves five basic steps: determining the issues or problems to be modeled; drawing a causal-loop diagram; drawing a dynamics model (DYNAMO) flow diagram to demonstrate the relationship between components; writing out DYNAMO equations to relate quantity to the time rate change of that quantity as a computer integration tool; and test for sensitivity and make simulation runs. With the aid of computer simulation, the model can identify both the magnitude and the timing of the effects of policy changes within the model. Policy alternatives may then be tested on the model of the system before being attempted within the actual financial system itself. A bibliography and a listing of equations for the model are included. (TR)

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A System Dynamics Approach to Understanding Cost
and Revenue Interactions in the
Community College Financial System

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ABSTRACT

This paper identifies the complex components of the Community College Financial System. It presents one way of systematically beginning to understand the dynamics of the interactions among these components. The generic components discussed are: (a) Enrollment, (b) Costs, (c) Revenues, and (d) Tuition. The method used is to construct a simple, but relatively complete, system dynamics model of the financial system. With the aid of computer simulation, this model can identify both the magnitude and the timing of the effects of policy changes within the model. Policy alternatives may then be tested on a model of the system before they are attempted in the system.

Various explanations have been offered for the financial crisis in higher education (Denson, 1975; Lombardi, 1972). Despite their relative success in maintaining institutional "health," community colleges in California have been caught in a struggle among competing groups for the tax dollar.

Proposition 13, the Jarvis-Gann initiative which was recently approved by California voters two to one, has sent "shockwaves" throughout higher education by placing a strict limit on local property taxes (Watkins, 1978).

California community colleges are faced with the unpleasant short-term prospect of drastic reduction in the local property tax base. In the longer run it seems that the explosive growth years of the 1960s have begun to level off requiring administrators to deal with new types of problems--problems for which new solutions must be found.

But before solutions to these complex problems may be found, it would be helpful for the decision maker to have an understanding of the dynamic, or time varying, effects of policy alternatives in order to discover answers for the "what happens if . . . ?" questions proposed by administrators, legislators, and the voting public (Koltai, 1975).

In an era of runaway inflation, increasing costs and exaggerated accountability, community college administrators in California, and in the nation, are faced with numerous decision alternatives for which there is no constructive framework for decision making. In the absence of this framework, many will be forced to fall back on their

personal experiences as teachers and administrators and to compose an intuitive, mental model around which to base their opinions on policy.

One way of gaining a better understanding of the outcomes of corrective policies which may be proposed to resolve these complex problems is to build a model based upon certain assumptions about behavior in the problem area. Corrective policies may then be tested on the model before they are implemented in the real system. System dynamics is a methodology appropriate for the design of a descriptive, generic and dynamic social system model (Randers, 1973). It is particularly appropriate for asking "What if" questions. System dynamics was developed by Jay Forrester and his associates at the Massachusetts Institute of Technology, and it has been applied to a wide variety of problems, from urban growth and decline (Forrester, 1969) to industrial organizations (Forrester, 1961).

The advantages of system dynamics modeling are described in detail by John Collins in Alfeld and Graham (1976). Paramount among these advantages is the precision which is required to translate an often ambiguous mental model into a computer simulation model.

A computer model differs principally in complexity, precision, and explicitness from the informal, subjective explanation or "mental model" that people ordinarily construct as a basis for making decisions and taking actions. A computer model takes account of the total set of forces that are believed to have caused and to sustain some problematic state of affairs. Like the informal mental model, it is derived from a variety of data sources, including facts, theories, and educated guesses. Unlike the mental model, it is comprehensive, unambiguous, flexible, and subject to rigorous logical manipulation and testing. (p. IX)

With a system dynamics model, policy alternatives could be simulated on the model and provide the decision maker with a relatively

inexpensive method of viewing the results, or outcomes, of policy changes over a time frame of his/her own choosing. Once the results of policy runs have been ascertained, decision makers are in a better position to assign them values of relative worth.

This paper is directed to the need for a system dynamics analysis of a California Community College District in order to assess the possible effects of alternative policies upon the characteristic behavior modes of the interrelated components of the district.

Method

System dynamics is based upon the fact that many social systems exhibit certain similarities and that these similarities may be identified, regardless of the specific system which is being studied. The system structure provides a framework, or a theory for organization, around which the many bits and pieces of knowledge which are collected may be viewed.

The initial, and perhaps the most controversial, phase of system analysis is the determination of the boundaries of the system which will be studied. Forrester maintains that "any interaction which is essential to the behavior mode being investigated must be included inside the system boundary" (1968, p. 4-2). Of course, the determination of what is essential must ultimately be the decision of the model builder. The system boundary is the starting point for the conceptualization of those relationships within the boundary which create dynamic behavior.

Within the system boundary, the basic principle of system dynamics is the concept of feedback, which means simply that the system is influenced by its own past action. This past action of the system can serve to reinforce the growth or the decay of the system, positive feedback, or it can regulate the system toward a goal, negative feedback (Goodman, 1974). Every decision, or process that controls system action, is made within a feedback loop. "The decision is based on the available information; the decision controls an action that influences a system level; and new information arises to modify the decision stream" (Forrester, 1968, p. 404).

Within each feedback loop there are two fundamental types of variables--the level and the rate. The level variables describe the condition of the system at any particular point in time. They accumulate the results of action within the system. A level variable is only dependent on the past accumulation of its own rates of flow. It is not directly dependent upon any other level (Forrester, 1968, p. 4-7). A readily identifiable level in an educational system is the quantity of students who are enrolled. Many more levels could certainly be identified, depending upon the system boundaries.

Rate variables describe how the levels are changing (Forrester, 1968, p. 4-5). They represent activity, or flows, while the level variables represent the resulting state to which the system has evolved by rate activity upon an initial level value. The rates of flow determine the changes in the level variables, and the level variables, in turn, determine the values for the rates. The level of students in

a school might be regulated by an admission rate which increases the size of the level and by a graduation rate, or withdrawal rate, which reduces the size of the level.

A third type of variable, an auxiliary variable, is an algebraic subdivision of a rate. It is used to enhance the clarity and meaning of the rate. Often, rates can become extremely complex and must be broken down into their component parts. This is not meant as a contradiction to the earlier statement that systems are composed only of rates and levels because auxiliary variables are parts of rates. Auxiliaries may depend upon other auxiliaries, but, ultimately, all auxiliaries are components of rates (Forrester, 1968, p. 5-11).

Because of the interdependence between the values for levels and rates, any simulation of the system must begin from a set of specified, initial conditions (Forrester, 1968, p. 4-12). For instance, if the size of the student body is 10,000 students, the level variable representing the quantity of students enrolled in the model might assume an initial value of 10,000. Once this level variable is determined, the rates which describe the change in the level can generate activity within the level.

This is the basic structure of systems as conceived in the system dynamics paradigm. Behavior within the system is controlled by its own past action, its feedback.

The state of the system at any particular time is defined by level variables which represent the accumulated flows of activity within the system. These flows, or rates, define changes in the levels.

With an understanding of system dynamics as background, the process of converting a community college system into a system dynamics computer simulation model will now be reviewed.

The Community College Finance Model

There are five basic steps to building a system dynamics simulation model.

Determine the issues, or problems, to be modeled. The community college system in California might briefly be described as a system of tuition free, public colleges for which the only admission requirement is a high school diploma. Many of the expenditures within this system seem related to the quantity of students in attendance.

As students in California community colleges pay no tuition, a near perfect balance must be maintained between total costs and total revenues. While the revenues may occasionally exceed the costs, they should never be less than costs. Should costs exceed revenues, some mechanism must work to raise the level of revenues and eliminate the discrepancy. For this analysis, tuition has been selected.

What will be the effects upon selected variables in a single campus community college district in California as tuition is introduced?

Draw a causal-loop diagram. Causal-loop diagrams identify the feedback loops of the system in simple illustrations which allow the analyst to quickly communicate the structural assumptions that he has developed. Causal-loop diagrams are the preliminary sketches for

causal hypotheses. They further encourage the modeler to conceptualize real world systems in terms of feedback loops.

As the components of the system are identified, they are portrayed with an arrow drawn between them which indicates the direction of causal influences. No attempt is made in the causal-loop to distinguish whether or not a variable is a level or a rate. The arrow which is drawn between the system components also indicates the type of influence, either positive or negative. A positive relationship between two variables occurs if, all other things being equal, a change in one variable creates a change in the same direction in the other variable. A negative relationship occurs when the change is in the opposite direction (Goodman, 1974, p. 7).

The causal-loop diagram in Figure 1 illustrates the structural assumptions and the basic feedback loops in the Community College Finance Model. Four major sectors may be identified--an enrollment sector, a cost sector, a revenue sector, and a tuition sector.

Beginning with the enrollment sector, an admission rate permits students from three income categories to enter the community college. As the quantity of these students increases in size, the volume of weekly student contact hours (WSCH) increases, and the dollar amount of state revenue increases. But with the increase in WSCH comes a corresponding increase in the expenses of education. In California community colleges, these expenses are divided into seven object categories (Budget and Accounting Manual, 1978, pp. 11-12).

Total costs are equivalent to total revenues when no tuition is charged. Federal revenues are relatively fixed, generally in the

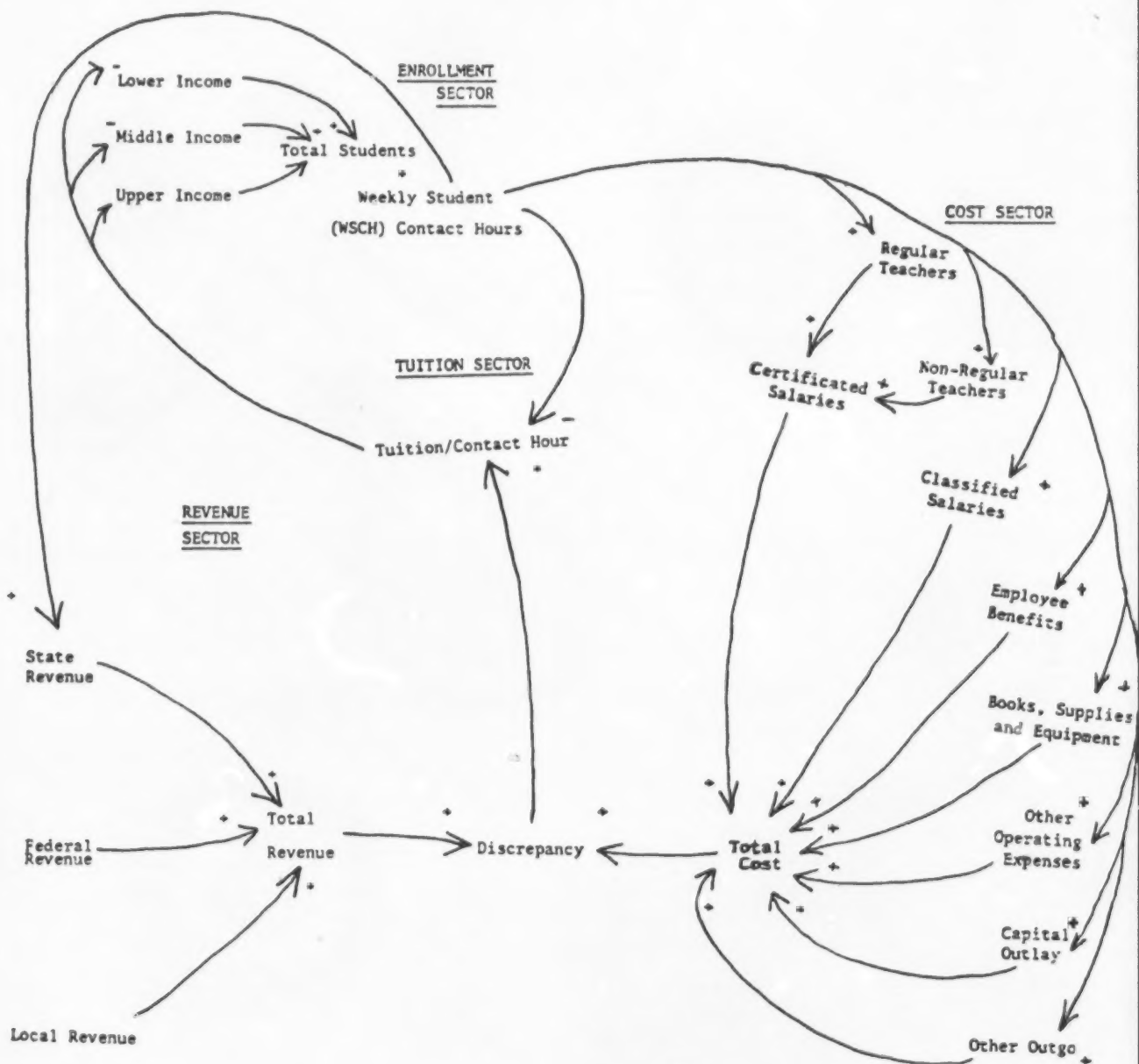


Figure 1: Causal-loop diagram

form of categorical aid (Stine, 1978). State revenues are derived from specific formulae and are related to the level of students through average daily attendance (California Postsecondary Education Commission, 1977). Local revenues serve as the balancing mechanism. Should this situation be altered and total costs exceed total revenues, a discrepancy would be created between total cost and total revenue--a deficit in the amount of available funds. This discrepancy could be alleviated by charging a tuition for each student contact hour. The tuition, however, creates a disturbance which influences the admission rate.

This description of the causal loop diagram in Figure 1 will serve as an overview for the more detailed discussion of each of the major sectors which follows. Table 1 is a documented listing of the acronyms which will be used in the DYNAMO flow diagrams to follow. DYNAMO is the software package which has been designed for use with system dynamics methodology. It is an acronym for DYNAmic MOdels.

Draw the DYNAMO flow diagram. The DYNAMO flow diagram which best represents the processes of the California Community College Finance Model is represented in Figure 2. The rectangles represent

the level variables for each of the three sectors which contain levels.

Table 1

Acronyms for Dynamic Flow Diagrams and Equations

PAGE 1	COMMUNITY COLLEGE FINANCE MODEL		7/25/78
NAME	NO	T	DEFINITION
A	78	A	INCREASE OVER PRIOR YEAR LEVEL(DOLLARS)
AA	75	A	TOTAL APPORTIONMENT FOR LARGE DISTRICT(DOLLARS)
ADA	42	A	AVERAGE DAILY ATTENDANCE(ADA)
ADDA	76	A	PRIOR YEAR ADA(ADA)
B	81	A	INCREASE DUE TO INCREASE IN ADA(DOLLARS)
BB	86	A	TOTAL APPORTIONMENT FOR SMALL DISTRICT(DOLLARS)
BSE	63	A	BOOKS SUPPLIES AND EQUIPMENT(DOLLARS)
BSEM	64	A	BOOKS SUPPLIES AND EQUIPMENT MULTIPLIER(DOLLARS)
BSENT	64.1	T	BOOKS SUPPLIES AND EQUIPMENT MULTIPLIER
C	82	A	CHANGE IN ADA FROM PRIOR YEAR(ADA)
CERTS	57	A	CERTIFICATED SALARIES(DOLLARS)
CLS	59	A	CLASSIFIED SALARIES(DOLLARS)
CLSM	60	A	CLASSIFIED SALARIES MULTIPLIER(DOLLARS)
CLSMT	60.1	T	CLASSIFIED SALARIES TABLE
CO	67	A	CAPITAL OUTLAY (DOLLARS)
COM	68	A	CAPITAL OUTLAY MULTIPLIER(DOLLARS)
COMT	68.1	T	CAPITAL OUTLAY MULTIPLIER TABLE
D	58.1	C	CONSTANT ANNUAL INFLATION(FRACTION/YEAR)
DISC	95	A	DISCREPANCY(DOLLARS)
DR	74	R	RATE OF CHANGE(DOLLARS/YEAR)
E	27.1	C	LPWRM CONSTANT
EB	61	A	EMPLOYEE BENEFITS(DOLLARS)
EBM	62	A	EMPLOYEE BENEFITS MULTIPLIER(DOLLARS)
EBMT	62.1	T	EMPLOYEE BENEFITS TABLE
EFM	80	A	EQUALIZATION FACTOR MULTIPLIER(DIMENSIONLESS)
EFMT	80.1	T	EQUALIZATION FACTOR MULTIPLIER TABLE
F	34.1	C	MPWRM CONSTANT
FR	91	A	FEDERAL REVENUE(DOLLARS)
G	84	A	DECREASE IN REVENUE DUE TO CHANGE IN ADA(DOLLARS)
H	85	A	CHANGE IN REVENUE OVER PRIOR YEARS LEVEL(DOLLARS)
HN	46.1	C	HIRING NORMAL(FRACTION/YEAR)
HR	46	R	HIRING RATE(TEACHERS/YEAR)
I	79.1	C	STATE INFLATION FACTOR(FRACTION/YEAR)
II	58	A	INFLATION FACTOR(DIMENSIONLESS)
J	82.1	C	STATE AID PER ADA(DOLLARS)
LENGTH			
LFAN	3	A	LOW INCOME FULL TIME ADMISSIONS NORMAL(FRACTION/YEAR)
LFAR	2	R	LOW INCOME FULL TIME ADMISSION RATE(STUDENTS/YEAR)
LFARM	4	A	LOW INCOME FULL TIME ADMISSION RATE MULTIPLIER(DIMENSIONLESS)
LFARMT	4.1	T	LOW INCOME FULL TIME ADMISSION RATE TABLE
LFS	1	L	LOW INCOME FULL TIME STUDENTS(FROM 0-7999 FAMILY INCOME)
LFWN	6	A	LOW INCOME FULL TIME WITHDRAWALS NORMAL(FRACTION / YEAR)
LFWR	5	R	LOW INCOME FULL TIME WITHDRAWAL RATE(STUDENTS/YEAR)

Table 1 (Continued)

PAGE 2	COMMUNITY COLLEGE FINANCE MODEL		7/25/78
LFWRM	7	A	LOW INCOME FULL TIME WITHDRAWAL RATE MULTIPLIER(DIMENSIONLESS)
LPAN	23	A	LOW INCOME PART TIME ADMISSIONS NORMAL(FRACTION/YEAR)
LPAR	22	R	LOW INCOME PART TIME ADMISSION RATE(STUDENTS/YEAR)
LPARM	24	A	LOW INCOME PART TIME ADMISSION RATE MULTIPLIER(DIMENSIONLESS)
LPARMT	24.1	T	LOW INCOME PART TIME ADMISSION RATE TABLE
LPS	21	L	LOW INCOME PART TIME STUDENTS(FROM 0-7999 FAMILY INCOME)
LPWN	26	A	LOW INCOME PART TIME WITHDRAWALS NORMAL(FRACTION/YEAR)
LPWR	25	R	LOW INCOME PART TIME WITHDRAWAL RATE(STUDENTS / YEAR)
LPWRM	27	A	LOW INCOME WITHDRAWAL RATE MULTIPLIER(DIMENSIONLESS)
LR	92	A	LOCAL REVENUE(DOLLARS)
M	91.1	C	FR CONSTANT(DOLLARS)
MFAN	10	A	MIDDLE INCOME FULL TIME ADMISSIONS NORMAL(FRACTION/YEAR)
MFAR	9	R	MIDDLE INCOME FULL TIME ADMISSION RATE(STUDENTS / YEAR)
MFARM	11	A	MIDDLE INCOME FULL TIME ADMISSION RATE MULTIPLIER(DIMENSIONLESS)
MFARMT	11.1	T	MIDDLE INCOME FULL TIME ADMISSION RATE TABLE
MFS	8	L	MIDDLE INCOME FULL TIME STUDENTS(FROM 8000- 24999 FAMILY INCOME)
MFWH	13	A	MIDDLE INCOME FULL TIME WITHDRAWALS NORMAL(FRACTION / YEAR)
MFWR	12	R	MIDDLE INCOME FULL TIME WITHDRAWAL RATE(STUDENTS/YEAR)
MFWRM	14	A	MIDDLE INCOME FULL TIME WITHDRAWAL RATE MULTIPLIER(DIMENSIONLESS)
MPAN	30	A	MIDDLE INCOME PART TIME ADMISSIONS NORMAL(FRACTION/YEAR)
MPAR	29	R	MIDDLE INCOME PART TIME ADMISSION RATE(STUDENTS/YEAR)
MPARM	31	A	MIDDLE INCOME PART TIME ADMISSION RATE MULTIPLIER(DIMENSIONLESS)
MPARMT	31.1	T	MIDDLE INCOME PART TIME ADMISSION TABLE
MPS	28	L	MIDDLE INCOME PART TIME STUDENTS(FROM 8000- 24999 FAMILY INCOME)
MPWN	28.1	N	MIDDLE INCOME PART TIME WITHDRAWALS NORMAL(FRACTION/YEAR)
MPWR	32	R	MIDDLE INCOME PART TIME WITHDRAWAL RATE(STUDENTS/YEAR)
MPWRM	34	A	MIDDLE INCOME PART TIME WITHDRAWAL RATE MULTIPLIER(DIMENSIONLESS)
MPWRN	33	A	MIDDLE INCOME PART TIME WITHDRAWAL RATE NORMAL(FRACTION/YEAR)
N	14.1	C	MFWRM CONSTANT
NRT	52	A	NON REGULAR TEACHERS(TEACHER)
NRTS	51	A	NON REGULAR TEACHING SECTIONS(SECTIONS)
NRTSA	55	A	NONREGULAR TEACHER SALARY(DOLLARS)
NTR	53	A	NON TEACHING REGULAR(NTR)
NTRMT	53.2	T	NON TEACHING REGULAR MULTIPLIER TABLE

Table 1 (Continued)

PAGE 3	COMMUNITY COLLEGE FINANCE MODEL		7/25/78
NTRSA	56	A	NONTEACHING REGULAR SALARY(DOLLARS)
OO	69	A	OTHER OUTGO
OQES	65	A	OTHER CPREATING EXPENSES AND SERVICES(DOLLARS)
OQESH	66	A	OTHER OPERATING EXPENSES AND SERVICES MULTIPLIER(DOLLARS)
OQESMT	66.1	T	OTHER CPREATING EXPENSES AND SERVICES TABLE
OQM	70	A	OTHER OUTGO MULTIPLIER(DOLLARS)
QOMT	70.1	T	OTHER OUTGO MULTIPLIER TABLE
P	77	A	APPORTIONMENT FOR LARGE DISTRICT WITH INCREASE IN ADA(DOLLARS)
PLTPER			PLOT PERIOD
PP	87	A	APPORTIONMENT FOR SMALL DISTRICT WITH INCREASE IN ADA(DOLLARS)
PRTPER			PRINT PERIOD
Q	83	A	APPORTIONMENT FOR LARGE DISTRICT WITH DECREASE IN ADA(DOLLARS)
QQ	88	A	APPORTIONMENT FOR SMALL DISTRICT WITH DECREASE IN ADA(DOLLARS)
QQQ	89	A	APPORTIONMENT FOR SMALL DISTRICT WITH DECREASE USING SDM(DOLLARS)
RN	50.1	C	RETIREMENTS NORMAL(FRACTION/YEAR)
RR	49	R	RETIREMENT RATE(TEACHERS/YEAR)
RRM	50	A	RETIREMENT RATE MULTIPLIER(DIMENSIONLESS)
RT	45	L	REGULAR TEACHERS(TEACHERS)
	45.1	N	
RTHM	47	A	REGULAR TEACHER HIRING MULTIPLIER(DIMENSIONLESS)
RTN	53.1	C	REGULAR TEACHERS NORMAL(TEACHERS)
RTS	48	A	REGULAR TEACHER SECTIONS(SECTIONS)
RTSA	54	A	REGULAR TEACHER SALARY(DOLLARS)
S	73	L	STATE REVENUE LEVEL(DOLLARS)
	73.1	N	
SDM	90	A	SMALL DISTRICT MULTIPLIER(DIMENSIONLESS)
SR	72	A	STATE REVENUE(DOLLARS)
SRR	79	A	STATE REVENUE FOR PRIOR YEAR(DOLLARS)
T	94	A	TUITION(DOLLARS/WSCH)
TC	71	A	TOTAL COST(DOLLARS)
TFS	20	A	TOTAL FULL TIME STUDENTS(STUDENTS)
TIME			TIME(YEARS)
TPS	40	A	TOTAL PART TIME STUDENTS(STUDENTS)
TR	93	A	TOTAL REVENUE(DOLLARS)
TS	43	A	TOTAL SECTIONS(SECTIONS)
U	41.1	C	WSCH PER PART TIME STUDENT(WSCH/PART TIME STUDENT)
UFAN	17	A	UPPER INCOME FULL TIME ADMISSION NORMAL(FRACTION / YEAR)
UFAR	16	R	UPPER INCOME FULL TIME ADMISSION RATE(STUDENTS/YEAR)
UFS	15	L	UPPER INCOME FULL TIME STUDENTS(ABOVE 25000 FAMILY INCOME)
	15.1	N	
UFWN	19	A	UPPER INCOME FULL TIME WITHDRAWALS NORMAL(FRACTION/YEAR)
UFWR	18	R	UPPER INCOME FULL TIME WITHDRAWAL RATE(STUDENTS/YEAR)
UPAN	37	A	UPPER INCOME PART TIME ADMISSIONS NORMAL(FRACTION/YEAR)

Table 1 (Continued)

PAGE 4		COMMUNITY COLLEGE FINANCE MODEL	7/25/78
UPAR	36	R	UPPER INCOME PART TIME ADMISSION RATE(STUDENTS/YEAR)
UPS	35	L	UPPER INCOME PART TIME STUDENTS(ABOVE 25000 FAMILY INCOME)
UPWN	39	A	UPPER INCOME PART TIME WITHDRAWALS NORMAL(FRACTION/YEAR)
UPWR	38	R	UPPER INCOME PART TIME WITHDRAWAL RATE(STUDENTS/YEAR)
V	52.1	C	SECTIONS PER NON REGULAR TEACHER(SECTIONS/ NRT)
W	54.1	C	RT SALARY(DOLLARS/RT)
WSCH	41	A	WEEKLY STUDENT CONTACT HOURS(WSCH)
X	7.1	C	LFWRM CONSTANT
Y	56.1	C	NTR SALARY(DOLLARS/NTR)
Z	55.1	C	NRT SALARY(DOLLARS/NRT)

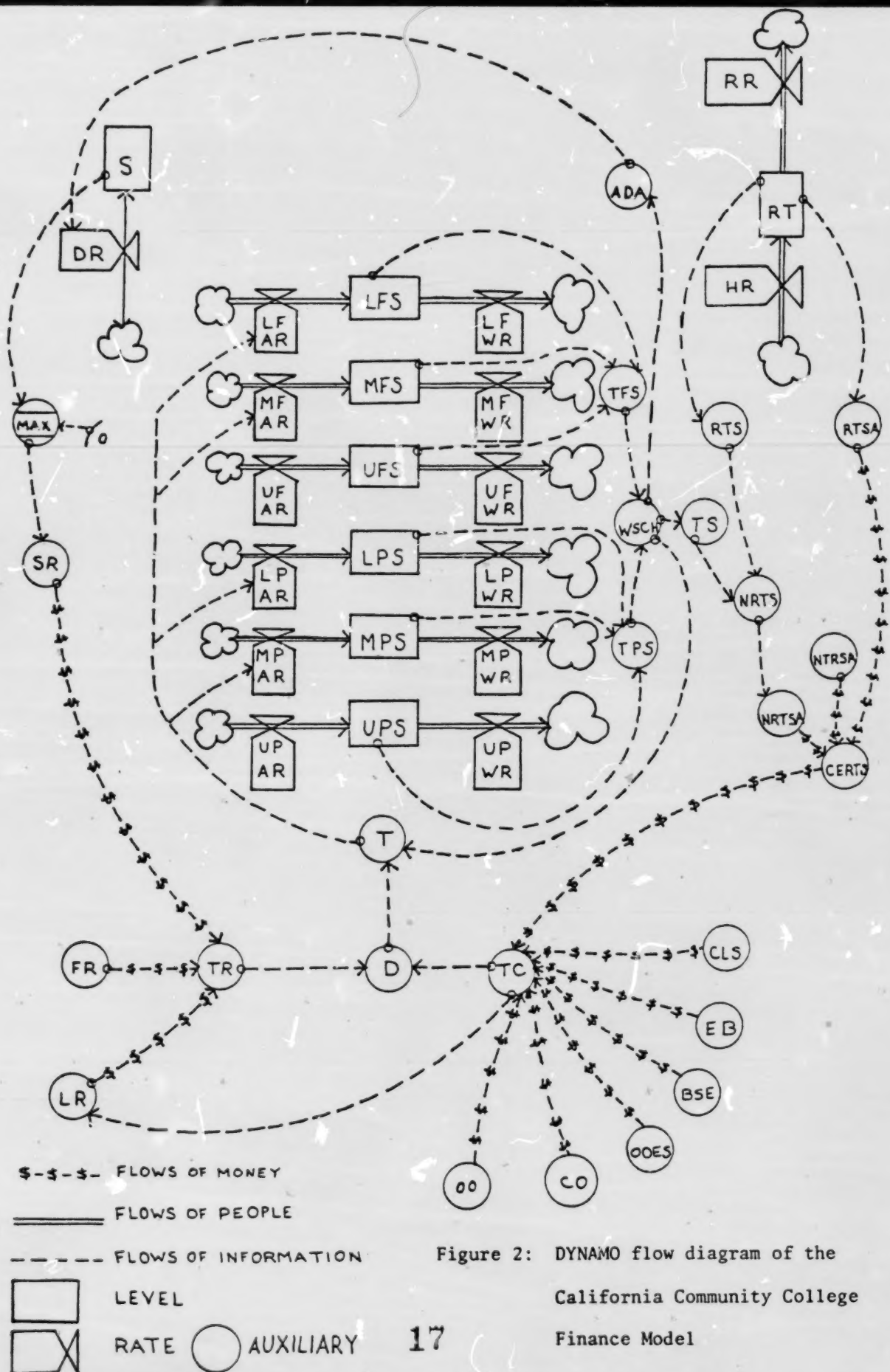


Figure 2: DYNAMO flow diagram of the California Community College Finance Model

The enrollment sector has six levels of students in order to account for both full time and part time students from three income categories. The cost sector has a single level of regular teachers (RT), and the revenue sector is described by the level of state revenues (S). The tuition sector does not contain a level variable. The rates are represented by the large "milk-cans" which are adjacent to the level variables. The circular symbols are auxiliary variables.

The lines in the flow diagram indicate the direction of the flow and the type of flow. For instance, a solid line indicates the movement of material, or physical flows, and the dashed lines indicate flows of information. Money flows are indicated by the \$ sign and people flows by two parallel lines. The flow diagram should provide still greater detail for the model than the causal-loop diagram.

Each of the four sectors will now be considered individually, and slightly more detailed flow diagrams will be described in order to further clarify this discussion of the Community College Finance Model. Parameters have been drawn from the Antelope Valley Community College District, a single campus district which lies north of Los Angeles in Southern California.

The Enrollment Sector

Figure 3 is a DYNAMO flow diagram for the enrollment sector. The enrollment sector is described by six levels of students which are categorized according to family income and according to their

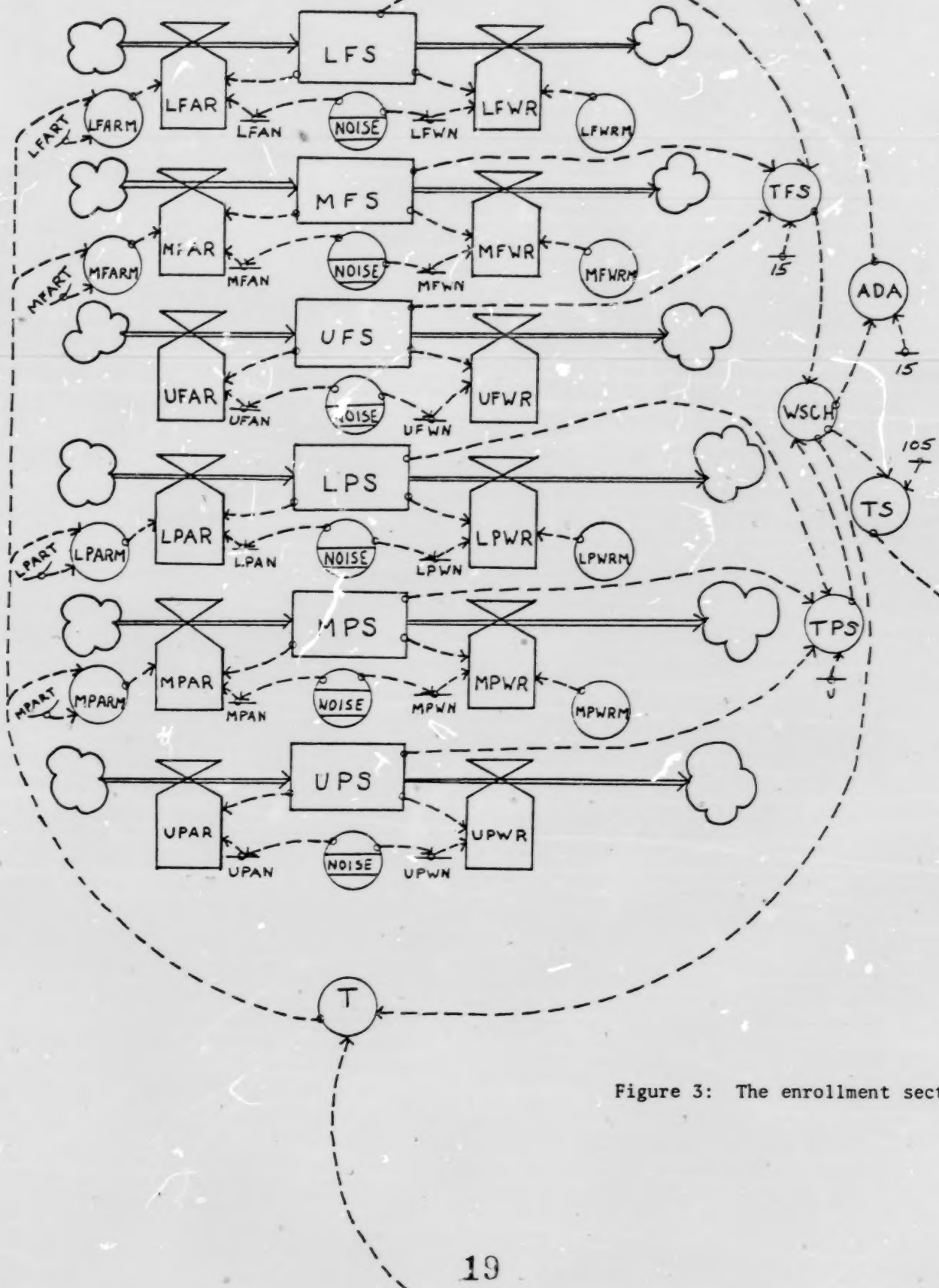


Figure 3: The enrollment sector

status as full time or part time students. Income categories are based upon a 1970 breakdown of Antelope Valley Family Income (Application for Reaffirmation of Accreditation, 1976). An assumption is made that the Antelope Valley Community College student body is representative of the larger population served by the college.

Each level of the enrollment sector is controlled by an admission rate and a withdrawal rate. The admission rates for lower and middle income students are the product of two auxiliaries and a level: (a) an admission rate multiplier which hypothesizes a relationship between admission for the particular income category and tuition, (b) a normal which is an expression in percentage form of the quantity of students normally admitted from that income category and (c) the level of students. The rates of admission are thus proportional to the size of the level. Random fluctuations of plus or minus 5% have been added to each of the normals in order that they might better represent real world random fluctuations which have varied from -7.7% to -.01% for full time students and from -5.07% to +5.3% for part time students between the fall semester 1976 and the spring semester 1978.

Withdrawal rates for the lower and middle income levels are also the product of two auxiliaries and a level: (a) a withdrawal multiplier which hypothesizes a relationship between withdrawals and tuition, (b) a normal which represents the percentage of students normally withdrawing from classes, and (c) the level of students. The withdrawal rate multiplier has been stabilized at unity for all fluctuations in tuition. Under these conditions, withdrawals will continue to remain

at between 25% and 35% of the size of the level regardless of the growth in tuition. Subsumed within the withdrawal rate are incompletes and failures.

There is ample support for an inverse relationship between the quantity of students enrolled, and the size of tuition in colleges (Carlson, Farmer & Weathersby, 1974; Suchar, et al., 1976; Jackson & Weathersby, 1975). The degree of this relationship has not been measured where a condition of no tuition has previously existed, although it seems reasonable that, if student aid is held constant, the low income group will suffer more substantial attrition because of the increased price than either middle or upper income groups.

If tuition is charged in California community colleges, it is likely that several related events will occur. Many full time students will reduce their workload and become part time students. Others will transfer to four year colleges and universities, either public or private, as tuition approaches competitive levels. Still others will simply leave school.

The reduction in full time students should be greater than the reduction in part time students, and the reduction of low income students should be greater than the reduction for either middle or upper income students.

If a tuition is charged, that tuition will cause the admission rate multiplier to generate a value which will be multiplied by the normal in order to generate a lower fraction of students who will be admitted to the college for each level of students except the upper

income levels. Both upper income levels are unaffected by tuition charges.

The six levels represent accumulations of students. When the three level variables which represent accumulations of full time students are added, an auxiliary variable is created for total full time students (TFS). Total part time students (TPS) is the result of the addition of the three levels for part time students. Total weekly student contact hours (WSCH) is the sum of WSCH for part time and full time students. When WSCH is divided by 15 contact hours for each unit of average daily attendance (ADA) the result is the total average daily attendance. WSCH divided by 105 WSCH for each classroom section gives the total sections (TS) for which instructors must be provided. The 105 WSCH per section is based on a student/teacher ratio of 35 to 1 for a three hour class.

Both ADA and total sections are important auxiliaries. ADA directly influences the level of state revenues, and the total sections influence the level of certificated salaries by determining the quantity of instructors who must be available to teach these sections (Stine, 1977).

In summary, the size of the tuition determines the level of students. The level of students determines the WSCH. The WSCH determines both the ADA and the total sections which must be taught.

The Revenue Sector

The revenue sector, as illustrated in Figure 4, has only one level--state revenue. The level of state revenue (S) is

altered by one rate (DR) which represents an annual increase or decrease in support, depending upon an increase or decrease in ADA over the prior year's ADA (ADDA) (California Postsecondary Education Commission, 1977). Federal revenue (FR) is represented as a constant with random fluctuations up to plus or minus 25%. Local revenue (LR) is the difference between total costs (TC) and the sum of state revenues and federal revenues.

The rate of change in state revenue is complex. In effect, there are four alternative formulae for changes in ADA from one year to the next. If the district to which funds are to be allocated is equal or greater than 3,001 ADA, it is considered to be a large district, and a certain set of relations apply depending on whether there has been growth or decline in ADA. If the district has less than 3,001 ADA, it is considered to be a small district and another set of relations apply, again depending upon whether ADA has increased or decreased.

The clip auxiliary permits the modeler to choose between two quantities on the basis of the relative values of two other quantities (Forrester, 1968, pp. 8-19). Four clip functions have been utilized in this rate equation to determine which set of equations is appropriate in the model. The first clip function compares ADA to a constant 3,001 in order to determine whether or not the large district formula or the small district formula should be applied. The total state apportionment for large

districts is represented by AA. The total state apportionment for small districts is represented by BB. The remaining clip functions compare current ADA to the prior year's ADA in order to determine whether or not to use formulae which are designed for an increase or for a decrease in ADA.

State revenue formulae are based on the level of funds for the prior year. Two adjustments are made to the prior year's level of funds, an adjustment to the level to bring it up to present value with additions for inflation and equalization regardless of a change in ADA and another adjustment in the state allocation because of a change in ADA which is derived when the numerical change in ADA [C] is multiplied by state aid per ADA [J].

When large districts of greater than 3,001 ADA experience growth, the adjustment to the prior year's level is made by adding an amount for inflation, an amount for equalization, and an amount for demographics. The inflation factor is a constant 6% increase per year. The equalization factor represents the ratio of state wide assessed valuation per ADA to the local ratio of assessed valuation per ADA. Wealthier districts receive proportionately less state aid per ADA because of the equalization factor, and poorer districts receive proportionately more aid. The equalization factor has been written as a multiplier, EFM, which increases in size from 1.09 to 1.20 over a 20 year period. The Antelope Valley District is getting poorer. The demographic factor is restricted to a few large urban districts in California and will not be considered here. The California Post-secondary Education Commission has reviewed these adjustments in

detail in its 1977 report.

An adjustment for an increase in ADA is then added to the prior year's allocation which has been adjusted for inflation and equalization. The numerical increase in ADA is multiplied by the amount of state aid per ADA. This product is then increased by the inflation factor and the equalization factor. The total allocation for a large district which experiences growth is represented in Figure 4 by the auxiliary P.

When large districts experience a decline in ADA, the decrease in revenue which results because of the decrease in ADA is computed without inflationary and equalization adjustments. This amount is then deducted from the prior year's level which has been brought up to present value by the action of the inflation and equalization factors of the state revenue formula. This activity is represented in the flow diagram by the auxiliary Q.

The distinguishing feature in the allocation formula between the large district and the small district is a fraction known as the small district multiplier (SDM). The small district multiplier increases in size as ADA decreases. The smaller the size of the district's ADA, the greater will be the state revenue allocated to that district because of the action of this multiplier.

In summary, the allocation of state revenue is closely related to the ADA of the district. Adjustments are made to bring the prior year's level of revenue up to present value, and, this value is then increased if ADA increases or decreased if ADA decreases.

Federal revenue is represented by a constant amount of 277,000, plus or minus fluctuations of 25%.

Local revenue makes up the difference between the sum of state and federal revenues and total cost (TC).

Total revenue (TR) is the summation of these three major revenue categories--state revenue, federal revenue, and local revenue.

Cost Sector

Figure 5 depicts the flow diagram for the cost sector of the model. The expenses of California community colleges are divided into seven object categories numbered 2,000 through 7,000 (Budget and Accounting Manual, California Community Colleges, 1978). The task

of modeling each of these object categories separately was considered and rejected. Each classification bears a relationship to the size of the student body, some more directly than others. As the most comprehensive measurement of student body size available is WSCH, table functions were constructed for object classifications 2,000 through 7,000 which describe the relationship between WSCH and the particular object classification.

The only object category which was modeled separately was certificated salaries (CERTS). This was necessary in order to track the three major recipients of certificated salaries: (a) regular

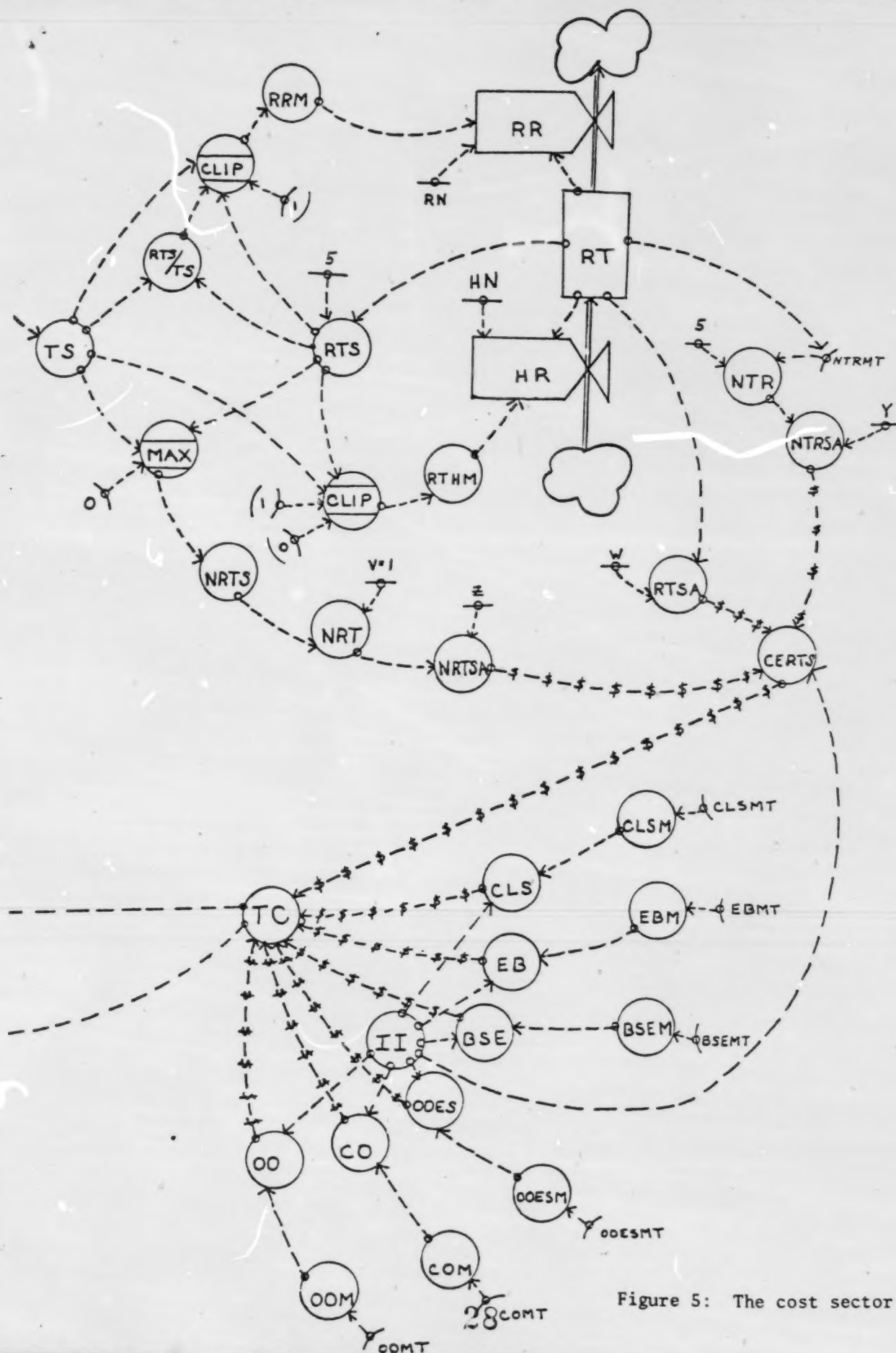


Figure 5: The cost sector

teachers, or full time contract teachers (RT): (b) non-regular teachers, or part timers (NRT): and (c) non-teaching regulars, or administrators (NTR).

Certificated salaries are modeled as a first order subsystem with the single level of regular teachers which is regulated by a hiring rate (HR) and a retirement rate (RR). The level for regular teachers has been initialized at a quantity of 72 teachers. These teachers should teach an average of five classes each at the community college level, or a total of 360 regular teacher sections (RTS).

The hiring rate for regular teachers is a product of a fraction which represents hiring normal (HN), a regular teacher hiring multiplier (RTHM) which adjusts the normal according to the quantity of sections available, and the level of regular teachers. Hiring normal is written at 5%. This was done to equate it with the 5% retirement normal which was noted at Antelope Valley Community College between 1969 and 1976 (Application for Reaffirmation of Accreditation, 1976). The hiring rate includes additions as well as replacements.

The regular teacher hiring multiplier is written as a clip function rather than as a table function. As long as the total number of sections remains greater than the number of sections available to regular teachers, the hiring rate will be the normal 5% per year. In the event that the total number of sections drops below regular teacher sections, the hiring rate is reduced to zero, and the hiring of regular contract teachers is frozen.

The retirement rate includes terminations, deaths, and absences for leave, as well as formal retirements. It also is the product of

a normal, a multiplier, and the level of regular teachers. The normal figure for retirements is 5% of the level of regular teachers. As long as the number of total sections remains greater than, or equal to, the number of regular teacher sections, regular teachers will continue to leave the level at the normal rate of 5%. Should the number of total sections fall below the number of regular teacher sections, the retirement rate will increase by the ratio of regular teacher sections to total sections. In other words, if total sections is reduced to 180, the retirement rate will be increased by $360/180$, or twice its normal rate. This will occur at the same time hiring is frozen by the Regular Teacher Hiring Multiplier. As in the real system, a reduction in total sections below the normal must reduce the number of regular teachers. The number of regular teachers will not fluctuate with changes in the size of the student body unless the WSCH drops so low as to force a reduction in the total sections available for them to teach.

Non-regular teachers (NRT), or part time teachers, bear a more direct relationship to total sections. The number of non-regular teachers expands, or contracts, directly with the availability of non-regular teacher sections (NRTS). Non-regular teacher sections are the difference between total sections and regular teacher sections. The assumption is made that each non-regular teacher section will be taught by one non-regular teacher. For instance, if total sections is equal to 400 and regular teacher sections is equal to 360, then 40 non-regular teacher sections are available to be filled by 40 non-regular teachers.

Non-teaching regulars, or administrators, are represented by the product of a normalized table function which adjusts the relationship between non-teaching regulars and regular teachers, and a constant five non-teaching regulars (Alfeld & Graham, 1976, pp. 154-57).

The non-teaching regular multiplier table (NTRMT) specifies that non-teaching regulars will increase by 20% if regular teachers increase by 50% but that non-teaching regulars will reduce by 50% if the number of regular teachers reduces by 50%.

This multiplier describes economies of scale for non-teaching regulars as regular teachers decrease. It does not account for extreme values, but it does describe changes in non-teaching regulars as regular teachers fluctuate between 50% and 150% of the normal.

Salaries for these three groups of certificated employees are the product of the number of personnel within each category and a constant salary. The sum of the salaries for these three groups represents total certificated salaries (CERTS).

Object classifications 2,000 through 7,000 have not been disaggregated in the same manner as object classification 1,000. A review of the budgets for Antelope Valley Community College over a ten year period from 1966 through 1976 revealed certain consistencies in the variability of costs for increases in WSCH.

Cost data was recorded and correlated with WSCH for the same time period. Interpolation was used to manipulate the data into a form suitable for use with DYNAMO table functions.

Each of the table functions for the six object categories 2,000 through 7,000 is multiplied by an inflation factor which adjusts

each figure for an annual 8% inflation rate (II).

Total cost is the summation of the values for each of the seven individual object categories of expense.

Tuition Sector

The tuition sector links the elements from the other three sectors. As the model is currently written, local revenue acts as an equilibrating factor between total cost and total revenue. However, by revising local revenue such that only a fraction of the necessary funding is provided, a discrepancy (D) is induced between total revenue and total cost. If this discrepancy is divided by the WSCH, the quotient is the amount of money which must be charged each student for each credit hour in which he engages. Tuition is the dollar amount which must be charged each student in order to eliminate the discrepancy. It will vary with the size of the discrepancy and with the size of WSCH. Variable tuition will also influence the four admission rate multipliers of the enrollment sector.

Flow diagrams are one way of communicating a system dynamics model. They are more exact than causal-loop diagrams, but they still do not precisely describe the activity of the model. This paper will not attempt to introduce the DYNAMO software package in any degree of complexity other than to suggest that it has been developed for problem oriented administrators rather than computer oriented technicians. DYNAMO relies upon the modeler to develop his/her own acronyms for the system variables. It combines this facility with extensive error checking so that the modeler can write his/her own

variables into the equations and control the time frame for the model simulation without being subjected to a number of arbitrary conventions which are often found in other computer languages. By reducing the number of filters which are usually required in translating administrative concepts into computer equations, DYNAMO reduces the possibility of a loss of control in the modeling process. Since there are not a number of arbitrary conventions, the user is free to concentrate on the really important area in which he/she, the administrator, is expert--the complex system which he/she directs (Pugh, 1973).

Write the DYNAMO II Equations

This step is the actual programming of the simulation. The basic tool of continuous simulation is integration. This is the process that relates a quantity to the time rate of change of that quantity. In equation form, this means that:

$$\begin{aligned} \text{Quantity at present time} &= \text{quantity at past time} + \\ &\text{time change} * \text{rate of change} \end{aligned}$$

DYNAMO differs from other computer languages in its use of time postscripts which indicate the time relations among the variables. The DYNAMO compiler accepts a model written in the form of the level, rate, and auxiliary equations which use the time postscript conventions, and it produces the requested simulation results in the form of numerical tables and graphical plots (Forrester, 1968, p. 8-1).

The postscript, "K," has arbitrarily been adopted to designate that point in time to which the current computation applies. The

postscript, "J," refers to the immediately preceding computation, and "L" refers to the next future computation. A level in the past computation would be postscripted .J. A level in the present computation would be postscripted .K. A rate of flow from the past to the present would be postscripted .JK. A rate of flow from the present to the next future computation would be postscripted .KL. When DYNAMO postscripts are added to the preceding equation, the result is a more concise expression of the time changes which are represented by the equation:

$$\text{quantity .K} = \text{quantity .J} + \Delta T * \text{rate of change .JK}$$

This particular type of equation is called a level equation and the quantity is called a level in DYNAMO parlance (Pugh, 1973, p. 2).

Writing level equations requires little more than the ability to identify the level. But the accuracy of the level equations is determined by the accuracy of the rate equations which represent the degree of change in the level over time.

For instance, the level of low income, full time students at the present time is equal to the level of low income, full time students at a past time period plus the product of the time difference and the change in the level per fraction of time. The change in the level of low income, full time students is represented by the difference between the admissions rate and the withdrawal rate for low income students.

ENROLLMENT SECTOR
LOW INCOME FULL TIME STUDENTS

$$LFS.K = LFS.J + DT * (LFAR.JK - LFWR.JK)$$

LFS=502

1. L

1.1. N

LFS - LOW INCOME FULL TIME STUDENTS (FROM 0-7999
FAMILY INCOME)

LFAR - LOW INCOME FULL TIME ADMISSION
RATE (STUDENTS/YEAR)

LFWR - LOW INCOME FULL TIME WITHDRAWAL
RATE (STUDENTS/YEAR)

The low income, full time admission rate controls entrance into the level.

$$LFAR.KL = LFARM.K * LFAN.K * LFS.K$$

2. R

LFAR - LOW INCOME FULL TIME ADMISSION
RATE (STUDENTS/YEAR)

LFARM - LOW INCOME FULL TIME ADMISSION RATE
MULTIPLIER (DIMENSIONLESS)

LFAN - LOW INCOME FULL TIME ADMISSIONS
NORMAL (FRACTION/YEAR)

LFS - LOW INCOME FULL TIME STUDENTS (FROM 0-7999
FAMILY INCOME)

The low income, full time admission rate is equal to the product of two auxiliaries and the low income full time student level. The low income full time admission rate multiplier (LFARM) describes the relation between low income students and tuition. The low income full time admissions normal (LFAN) represents the students who would enter school each year as a percentage of the total student body. The withdrawal rate is similarly written.

$$LFWR.KL = LFWRM.K * LFWN.K * LFS.K$$

5. R

LFWR - LOW INCOME FULL TIME WITHDRAWAL
RATE (STUDENTS/YEAR)

LFWRM - LOW INCOME FULL TIME WITHDRAWAL RATE
MULTIPLIER (DIMENSIONLESS)

LFWN - LOW INCOME FULL TIME WITHDRAWALS
NORMAL (FRACTION / YEAR)

LFS - LOW INCOME FULL TIME STUDENTS (FROM 0-7999
FAMILY INCOME)

When writing the equations, all level variables must be assigned initial values, and the time horizon over which the system is to be observed must be determined. When this phase of the model is completed, the modeler is ready to test for sensitivity and validity.

Test for sensitivity and make simulation runs. This fifth step is the obvious conclusion to the model building process. All parameters were tested for sensitivity with favorable results. The issue of validity and confidence in the model will be discussed briefly.

Gaining Confidence in the Model

The concept of validity as it applies to statistical models is not applicable to "the state-variable non-linear structures drawn from mental and descriptive models" which are system dynamics models (Forrester, 1973, p. 4). Forrester has designed 13 tests which assist the modeler in gaining confidence in the model. It is not necessary to "pass" all of the tests in order to have an effective system dynamics model, but, by satisfying the requirements for each test, greater confidence is gained in the effectiveness of the model.

The Community College Finance Model successfully completed 10 of the 13 tests. Two of these tests cannot be conducted under the conditions for which this model was designed, and the third test, point prediction, Forrester suggests may be inappropriate for system dynamics models which are designed to assist in policy analysis rather than specific future prediction.

Model simulation. Three computer simulation runs were completed with this model. Figure 6 is a graphic illustration of the model in operation when total revenue exactly equals total cost. Figure 7 shows

the model in operation when tuition has been introduced to remove a 20% discrepancy.

Tables 2 and 3 illustrate the changes in selected variables

as the model is simulated over a 20 year period.

Figure 8 illustrates the middle income flight hypothesis predicted by Leslie and Johnson (1977) who hypothesize that, under conditions of increasing tuition, lower income students will receive government subsidies which enable them to remain in school, while middle income students, without these subsidies, are forced out of

PAGE 6 COMMUNITY COLLEGE FINANCE MODEL 7/25/78 11:24 NO DISCREPANCY

T=T, TFS=F, TPS=P, L=L, S=S, CERTS=1

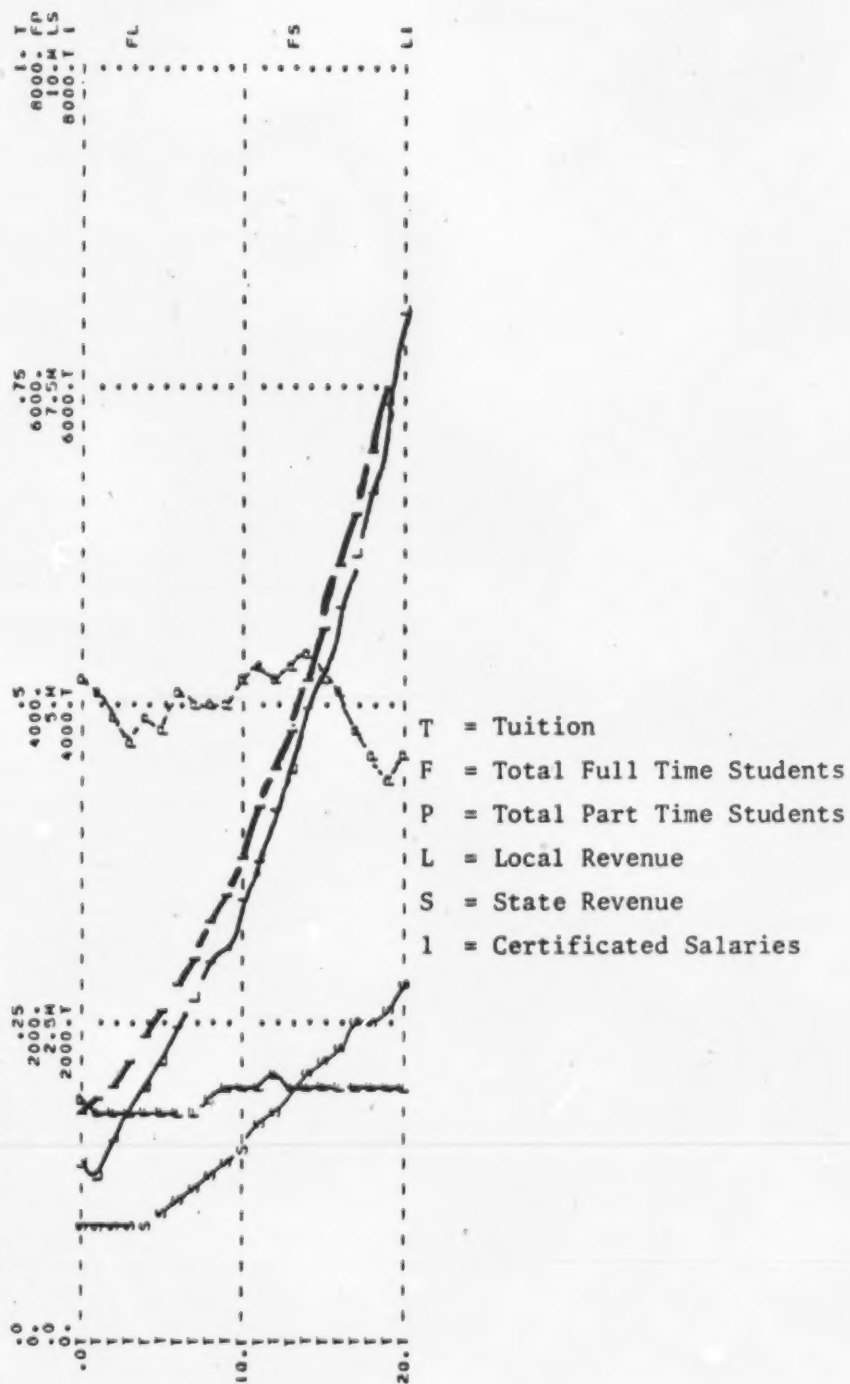


Figure 6: Total cost = total revenue,
model is in steady state

PAGE 8 COMMUNITY COLLEGE FINANCE MODEL 7/25/78 11:33 20% DISCREPANCY--TUITION IS CHARGED

T=T, TFS=F, TPS=P, LR=L, SR=S, CERTS=I

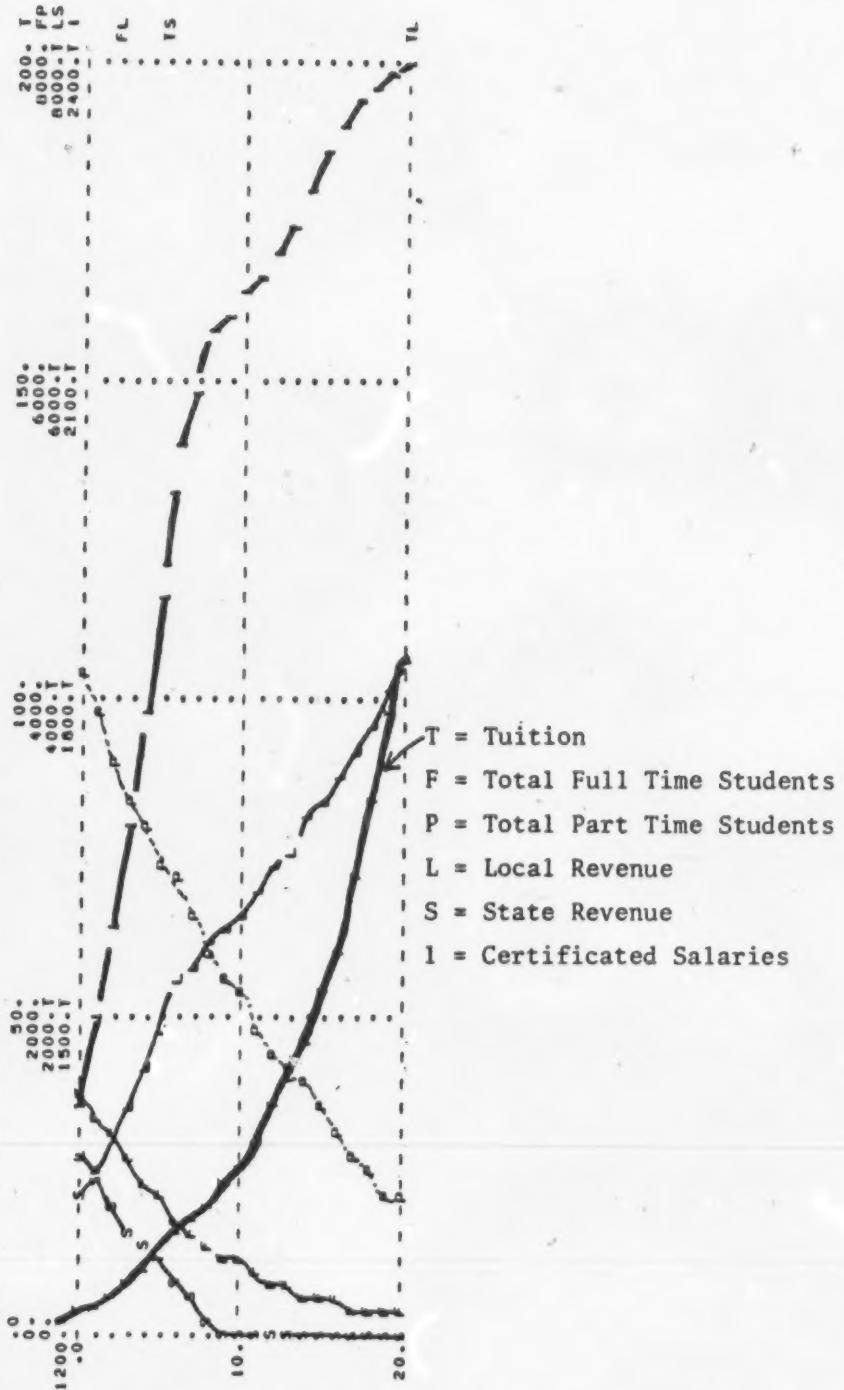


Figure 7: Discrepancy between total cost and total revenue

Table 2

Selected Variables When Model is in Steady State

	Time in Years										
	<u>0</u>	<u>2</u>	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>14</u>	<u>16</u>	<u>18</u>	<u>20</u>
TUITION	0	0	0	0	0	0	0	0	0	0	0
LFS	502	434	456	439	461	446	423	416	391	372	389
MFS	985	972	932	914	986	1088	1137	1070	1107	1149	1116
UFS	71	66	68	77	83	86	83	78	78	73	74
LPS	1332	1303	1320	1324	1342	1356	1368	1320	1164	1079	981
MPS	2613	2419	2387	2538	2441	2647	2637	2805	2747	2407	2514
UPS	187	183	184	182	179	185	176	170	168	176	165
RT	72	72	72	72	72	72	72	72	72	72	72
NRT	209	178	174	183	191	222	225	223	207	175	172
NTR	5	5	5	5	5	5	5	5	5	5	5
SR (1000s)	874	886	919	1079	1267	1527	1845	2065	2340	2531	2797
FR (1000s)	216	266	321	271	240	312	221	212	256	308	252
LR (1000s)	1351	1640	2011	2462	2955	3482	4150	4966	5757	6715	8080
CERTS (1000s)	1417	1630	1898	2223	2601	3079	3596	4191	4852	5575	6496

Table 3

Selected Variables When Tuition is Charged to Eliminate Discrepancy

	Time in Years										
	<u>0</u>	<u>2</u>	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>14</u>	<u>16</u>	<u>18</u>	<u>20</u>
TUITION	4.5	6.4	9.6	15.1	20.7	26.3	35.6	45.8	60.6	83.4	107.0
LFS	502	332	238	144	74	40	20	10	5	3	2
MFS	985	853	681	517	413	320	244	167	124	91	62
UFS	71	66	68	77	83	86	83	78	78	73	74
LPS	1332	1158	983	774	578	430	312	223	144	95	64
MPS	2613	2277	2058	1944	1628	1507	1289	1185	989	750	666
UPS	187	183	184	182	179	185	176	170	168	176	165
RT	72	72	72	72	65	57	51	44	39	33	28
NRT	209	122	51	0	0	0	0	0	0	0	0
NTR	5	5	5	5	5	3	3	3	3	3	3
SR (1000s)	874	766	535	332	111	0	0	0	0	0	0
FR (1000s)	329	266	321	271	240	312	221	212	256	308	252
LR (1000)	1040	1300	1667	2202	2441	2666	2963	3250	3526	3827	4248
CERTS (1000s)	1495	1588	1790	2034	2146	2179	2216	2280	2338	2379	2399

the classroom. The middle income flight hypothesis assumes that alterations will be made in the level of student aid in order to compensate low income students for increasing tuition. While the model does not alter the student aid which is available to low income students, the desired effect may be created by modifying the admission rate tables to correspond to the hypothesis.

Discussion

When no discrepancy exists, the size of the student body fluctuates randomly, but with no significant increases, or decreases, in quantity. As a discrepancy of 20% is introduced into the system, the system loses students until the system again achieves an equilibrium.

When tuition exists, regardless of its size, the greatest losses are in full time students. Non-regular, or part time, teachers are lost in direct proportion to the loss in WSCH. Regular teachers and non-teaching regulars are less responsive to reductions in WSCH.

State revenues are related to the loss in ADA and, eventually, they are reduced to zero. Admittedly this is an unlikely circumstance, but, as state revenue formulae are currently written, this is indeed the result of the prolonged reduction in ADA.

Local revenue continued to rise after a dramatic initial reduction although enrollment is reducing substantially. Local revenue is related to total costs which continue to rise in actual dollars because of the effects of inflation even when WSCH is declining. Drastic reduction in state revenue because of the loss of ADA places an additional



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burden on local revenue.

Conclusions

A generic, descriptive system dynamics model has been constructed of a single campus, California community college district. With no more refinement than currently exists, the model should provide an effective analytical tool for community college administrators who must consider the dynamic effects of policy change on the system as a whole rather than on isolated components of the system.

An additional advantage which the Community College Finance Model provides to the administrator is its easy communicability to those less sophisticated in the operations of the real system--specifically, the district board. The entire structure of the system can be examined in terms of the causal loop diagram with reference to the more complex flow diagrams or DYNAMO equations only when necessary. Output from the model simulation can be examined in easy to read graphic displays, or reference may be made to the statistics upon which the graphs are based.

Two recommendations seem most important. First, the boundaries of the model should be extended in future models. This would permit a more extensive analysis of the revenue and cost sectors. Second, the object classifications 2,000 through 7,000 which were aggregated as table functions should be modeled individually.

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Documented Listing of Equations
for the
Community College Finance Model

PAGE 1

COMMUNITY COLLEGE FINANCE MODEL

7/25/78

ENROLLMENT SECTOR
LOW INCOME FULL TIME STUDENTS

LFS.K=LFS.J+DT*(LFAR.JK-LFWR.JK) 1. L
LFS=502 1.1. N
LFS - LOW INCOME FULL TIME STUDENTS(FROM 0-7999
FAMILY INCOME)
LFAR - LOW INCOME FULL TIME ADMISSION
RATE(STUDENTS/YEAR)
LFWR - LOW INCOME FULL TIME WITHDRAWAL
RATE(STUDENTS/YEAR)

LFAR.KL=LFARM.K*LFAN.K*LFS.K 2. R
LFAR - LOW INCOME FULL TIME ADMISSION
RATE(STUDENTS/YEAR)
LFARM - LOW INCOME FULL TIME ADMISSION RATE
MULTIPLIER(DIMENSIONLESS)
LFAN - LOW INCOME FULL TIME ADMISSIONS
NORMAL(FRACTION/YEAR)
LFS - LOW INCOME FULL TIME STUDENTS(FROM 0-7999
FAMILY INCOME)

LFAN.K=.3+NOISE()*1 3. A
LFAN - LOW INCOME FULL TIME ADMISSIONS
NORMAL(FRACTION/YEAR)

LFARM.K=TABHL(LFARMT,T.K,0,20,4) 4. A
LFARMT=1/.6/.4/.2/.1/.05 4.1. T
LFARM - LOW INCOME FULL TIME ADMISSION RATE
MULTIPLIER(DIMENSIONLESS)
LFARMT - LOW INCOME FULL TIME ADMISSION RATE TABLE
T - TUITION(DOLLARS/WSCH)

LFWR.KL=LFWRM.K*LFWN.K*LFS.K 5. R
LFWR - LOW INCOME FULL TIME WITHDRAWAL
RATE(STUDENTS/YEAR)
LFWRM - LOW INCOME FULL TIME WITHDRAWAL RATE
MULTIPLIER(DIMENSIONLESS)
LFWN - LOW INCOME FULL TIME WITHDRAWALS
NORMAL(FRACTION / YEAR)
LFS - LOW INCOME FULL TIME STUDENTS(FROM 0-7999
FAMILY INCOME)

LFWN.K=.3+NOISE()*1 6. A
LFWN - LOW INCOME FULL TIME WITHDRAWALS
NORMAL(FRACTION / YEAR)

LFWRM.K=X 7. A
X=1 7.1. C
LFWRM - LOW INCOME FULL TIME WITHDRAWAL RATE
MULTIPLIER(DIMENSIONLESS)
X - LFWRM CONSTANT

MIDDLE INCOME FULL TIME STUDENTS

$MFS.K = MFS.J + DT * (MFAR.JK - MFWR.JK)$ 8. L
 $MFS = 985$ 8.1. N
 MFS - MIDDLE INCOME FULL TIME STUDENTS (FROM 8000-24999 FAMILY INCOME)
 $MFAR$ - MIDDLE INCOME FULL TIME ADMISSION RATE (STUDENTS / YEAR)
 $MFWR$ - MIDDLE INCOME FULL TIME WITHDRAWAL RATE (STUDENTS / YEAR)

$MFAR.KL = MFARM.K * MFAN.K * MFS.K$ 9. R
 $MFAR$ - MIDDLE INCOME FULL TIME ADMISSION RATE (STUDENTS / YEAR)
 $MFARM$ - MIDDLE INCOME FULL TIME ADMISSION RATE MULTIPLIER (DIMENSIONLESS)
 $MFAN$ - MIDDLE INCOME FULL TIME ADMISSIONS NORMAL (FRACTION / YEAR)
 MFS - MIDDLE INCOME FULL TIME STUDENTS (FROM 8000-24999 FAMILY INCOME)

$MFAN.K = .3 + NOISE() * .1$ 10. A
 $MFAN$ - MIDDLE INCOME FULL TIME ADMISSIONS NORMAL (FRACTION / YEAR)

$MFARM.K = TABHL(MFARMT, T, K, 0.20, .4)$ 11. A
 $MFARMT = 1/.8 / .7 / .6 / .55 / .5$ 11.1. T
 $MFARM$ - MIDDLE INCOME FULL TIME ADMISSION RATE MULTIPLIER (DIMENSIONLESS)
 $MFARMT$ - MIDDLE INCOME FULL TIME ADMISSION RATE TABLE
 T - TUITION (DOLLARS / WSCH)

$MFWR.KL = MFWRM.K * MFWN.K * MFS.K$ 12. R
 $MFWR$ - MIDDLE INCOME FULL TIME WITHDRAWAL RATE (STUDENTS / YEAR)
 $MFWRM$ - MIDDLE INCOME FULL TIME WITHDRAWAL RATE MULTIPLIER (DIMENSIONLESS)
 $MFWN$ - MIDDLE INCOME FULL TIME WITHDRAWALS NORMAL (FRACTION / YEAR)
 MFS - MIDDLE INCOME FULL TIME STUDENTS (FROM 8000-24999 FAMILY INCOME)

$MFWN.K = .3 + NOISE() * .1$ 13. A
 $MFWN$ - MIDDLE INCOME FULL TIME WITHDRAWALS NORMAL (FRACTION / YEAR)

$MFWRM.K = N$ 14. A
 $N = 1$ 14.1. C
 $MFWRM$ - MIDDLE INCOME FULL TIME WITHDRAWAL RATE MULTIPLIER (DIMENSIONLESS)
 N - MFWRM CONSTANT

UPPER INCOME FULL TIME STUDENTS

$UFS.K = UFS.J + DT * (UFAR.JK - UFWR.JK)$ 15. L
 $UFS = 71$ 15.1. N
 UFS - UPPER INCOME FULL TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)
 UFAR - UPPER INCOME FULL TIME ADMISSION
 RATE(STUDENTS/YEAR)
 UFWR - UPPER INCOME FULL TIME WITHDRAWAL
 RATE(STUDENTS/YEAR)

$UFAR.KL = UFAN.K * UFS.K$ 16. R
 UFAR - UPPER INCOME FULL TIME ADMISSION
 RATE(STUDENTS/YEAR)
 UFAN - UPPER INCOME FULL TIME ADMISSION
 NORMAL(FRACTION / YEAR)
 UFS - UPPER INCOME FULL TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

$UFAN.K = .3 + NOISE() * .1$ 17. A
 UFAN - UPPER INCOME FULL TIME ADMISSION
 NORMAL(FRACTION / YEAR)

$UFWR.KL = UFWN.K * UFS.K$ 18. R
 UFWR - UPPER INCOME FULL TIME WITHDRAWAL
 RATE(STUDENTS/YEAR)
 UFWN - UPPER INCOME FULL TIME WITHDRAWALS
 NORMAL(FRACTION/YEAR)
 UFS - UPPER INCOME FULL TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

$UFWN.K = .3 + NOISE() * .1$ 19. A
 UFWN - UPPER INCOME FULL TIME WITHDRAWALS
 NORMAL(FRACTION/YEAR)

TOTAL FULL TIME STUDENTS

$TFS.K = LFS.K + MFS.K + UFS.K$ 20. A
 TFS - TOTAL FULL TIME STUDENTS(STUDENTS)
 LFS - LOW INCOME FULL TIME STUDENTS(FROM 0-7999
 FAMILY INCOME)
 MFS - MIDDLE INCOME FULL TIME STUDENTS(FROM 8000-
 24999 FAMILY INCOME)
 UFS - UPPER INCOME FULL TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

LOW INCOME PART TIME STUDENTS

$LPS.K = LPS.J + DT * (LPAR.JK - LPWR.JK)$ 21. L
 $LPS = 1332$ 21.1. N
 LPS - LOW INCOME PART TIME STUDENTS(FROM 0-7999
 FAMILY INCOME)
 LPAR - LOW INCOME PART TIME ADMISSION
 RATE(STUDENTS/YEAR)
 LPWR - LOW INCOME PART TIME WITHDRAWAL
 RATE(STUDENTS / YEAR)

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LPAR.KL=LPARM.K*LPAN.K*LPS.K                                22. R
  LPAR - LOW INCOME PART TIME ADMISSION
          RATE(STUDENTS/YEAR)
  LPARM - LOW INCOME PART TIME ADMISSION RATE
          MULTIPLIER(DIMENSIONLESS)
  LPAN - LOW INCOME PART TIME ADMISSIONS
          NORMAL(FRACTION/YEAR)
  LPS - LOW INCOME PART TIME STUDENTS(FROM 0-7999
          FAMILY INCOME)

LPAN.K=.3+NOISE()*.1                                         23. A
  LPAN - LOW INCOME PART TIME ADMISSIONS
          NORMAL(FRACTION/YEAR)

LPARM.K=TABHL(LPAMT.T.K.0,20,4)                                24. A
LPAMT=1/.8/.7/.6/.55/.5                                     24.1. T
  LPARM - LOW INCOME PART TIME ADMISSION RATE
          MULTIPLIER(DIMENSIONLESS)
  LPAMT - LOW INCOME PART TIME ADMISSION RATE TABLE
  T - TUITION(DOLLARS/WSCH)

LPWR.KL=LPWRM.K*LPWN.K*LPS.K                                25. R
  LPWR - LOW INCOME PART TIME WITHDRAWAL
          RATE(STUDENTS / YEAR)
  LPWRM - LOW INCOME WITHDRAWAL RATE
          MULTIPLIER(DIMENSIONLESS)
  LPWN - LOW INCOME PART TIME WITHDRAWALS
          NORMAL(FRACTION/YEAR)
  LPS - LOW INCOME PART TIME STUDENTS(FROM 0-7999
          FAMILY INCOME)

LPWN.K=.3+NOISE()*.1                                         26. A
  LPWN - LOW INCOME PART TIME WITHDRAWALS
          NORMAL(FRACTION/YEAR)

LPWRM.K=E                                                    27. A
E=1                                                         27.1. C
  LPWRM - LOW INCOME WITHDRAWAL RATE
          MULTIPLIER(DIMENSIONLESS)
  E - LPWRM CONSTANT

MIDDLE INCOME PART TIME STUDENTS

MPS.K=MPS.J+DT*(MPAR.JK-MPWR.JK)                                28. L
MPS=2613                                                         28.1. N
  MPS - MIDDLE INCOME PART TIME STUDENTS(FROM 8000-
          24999 FAMILY INCOME)
  MPAR - MIDDLE INCOME PART TIME ADMISSION
          RATE(STUDENTS/YEAR)
  MPWR - MIDDLE INCOME PART TIME WITHDRAWAL
          RATE(STUDENTS/YEAR)

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MPAR.KL=MPARM.K*MPAN.K*MPS.K 29. R
 MPAR - MIDDLE INCOME PART TIME ADMISSION
 RATE(STUDENTS/YEAR)
 MPARM - MIDDLE INCOME PART TIME ADMISSION RATE
 MULTIPLIER((DIMENSIONLESS)
 MPAN - MIDDLE INCOME PART TIME ADMISSIONS
 NORMAL(FRACTION/YEAR)
 MPS - MIDDLE INCOME PART TIME STUDENTS(FROM 8000-
 24999 FAMILY INCOME)

MPAN.K=.3+NOISE()*.1 30. A
 MPAN - MIDDLE INCOME PART TIME ADMISSIONS
 NORMAL(FRACTION/YEAR)

MPARM.K=TABHL(MPARMT.T.K,0,20,4) 31. A
 MPARMT=1/.9/.85/.8/.775/.75 31.1. T
 MPARM - MIDDLE INCOME PART TIME ADMISSION RATE
 MULTIPLIER((DIMENSIONLESS)
 MPARMT - MIDDLE INCOME PART TIME ADMISSION TABLE
 T - TUITION(DOLLARS/WSCH)

MPWR.KL=MPWRM.K*MPWRN.K*MPS.K 32. R
 MPWR - MIDDLE INCOME PART TIME WITHDRAWAL
 RATE(STUDENTS/YEAR)
 MPWRM - MIDDLE INCOME PART TIME WITHDRAWAL RATE
 MULTIPLIER(DIMENSIONLESS)
 MPWRN - MIDDLE INCOME PART TIME WITHDRAWAL RATE
 NORMAL(FRACTION/YEAR)
 MPS - MIDDLE INCOME PART TIME STUDENTS(FROM 8000-
 24999 FAMILY INCOME)

MPWRN.K=.3+NOISE()*.1 33. A
 MPWRN - MIDDLE INCOME PART TIME WITHDRAWAL RATE
 NORMAL(FRACTION/YEAR)

MPWRM.K=F 34. A
 F=1 34.1. C
 MPWRM - MIDDLE INCOME PART TIME WITHDRAWAL RATE
 MULTIPLIER(DIMENSIONLESS)
 F - MPWRM CONSTANT

UPPER INCOME PART TIME STUDENTS

UPS.K=UPS.J+DT*(UPAR.JK-UPWR.JK) 35. L
 UPS=187 35.1. N
 UPS - UPPER INCOME PART TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)
 UPAR - UPPER INCOME PART TIME ADMISSION
 RATE(STUDENTS/YEAR)
 UPWR - UPPER INCOME PART TIME WITHDRAWAL
 RATE(STUDENTS/YEAR)

UPAR.KL=UPAN.K*UPS.K 36. R
 UPAR - UPPER INCOME PART TIME ADMISSION
 RATE(STUDENTS/YEAR)
 UPAN - UPPER INCOME PART TIME ADMISSIONS
 NORMAL(FRACTION/YEAR)
 UPS - UPPER INCOME PART TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

UPAN.K=.3+NOISE()*1 37. A
 UPAN - UPPER INCOME PART TIME ADMISSIONS
 NORMAL(FRACTION/YEAR)

UPWR.KL=UPWN.K*UPS.K 38. R
 UPWR - UPPER INCOME PART TIME WITHDRAWAL
 RATE(STUDENTS/YEAR)
 UPWN - UPPER INCOME PART TIME WITHDRAWALS
 NORMAL(FRACTION/YEAR)
 UPS - UPPER INCOME PART TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

UPWN.K=.3+NOISE()*1 39. A
 UPWN - UPPER INCOME PART TIME WITHDRAWALS
 NORMAL(FRACTION/YEAR)

TOTAL PART TIME STUDENTS

TPS.K=LPS.K+MPS.K+UPS.K 40. A
 TPS - TOTAL PART TIME STUDENTS(STUDENTS)
 LPS - LOW INCOME PART TIME STUDENTS(FROM 0-7999
 FAMILY INCOME)
 MPS - MIDDLE INCOME PART TIME STUDENTS(FROM 8000-
 24999 FAMILY INCOME)
 UPS - UPPER INCOME PART TIME STUDENTS(ABOVE 25000
 FAMILY INCOME)

TOTAL WEEKLY STUDENT CONTACT HOURS

WSCH.K=TFS.K*15+TPS.K*U 41. A
 U=8.8 41.1. C
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)
 TFS - TOTAL FULL TIME STUDENTS(STUDENTS)
 TPS - TOTAL PART TIME STUDENTS(STUDENTS)
 U - WSCH PER PART TIME STUDENT(WSCH/PART TIME
 STUDENT)

AVERAGE DAILY ATTENDANCE

ADA.K=WSCH.K/15 42. A
 ADA - AVERAGE DAILY ATTENDANCE(ADA)
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

TOTAL SECTIONS

TS.K=WSCH.K/105 43. A
 TS - TOTAL SECTIONS(SECTIONS)
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

COST SECTOR
CERTIFICATED SALARIES
REGULAR TEACHERS

RT.K=RT.J+DT*(HR.JK-RR.JK) 45. L
RT=72 45.1, N
RT - REGULAR TEACHERS(TEACHERS)
HR - HIRING RATE(TEACHERS/YEAR)
RR - RETIREMENT RATE(TEACHERS/YEAR)

HR.KL=HN*RTHM.K*RT.K 46. R
HN=.05 46.1, C
HR - HIRING RATE(TEACHERS/YEAR)
HN - HIRING NORMAL(FRACTION/YEAR)
RTHM - REGULAR TEACHER HIRING
MULTIPLIER(DIMENSIONLESS)
RT - REGULAR TEACHERS(TEACHERS)

RTHM.K=CLIP(1.0,TS.K,RTS.K) 47. A
RTHM - REGULAR TEACHER HIRING
MULTIPLIER(DIMENSIONLESS)
TS - TOTAL SECTIONS(SECTIONS)
RTS - REGULAR TEACHER SECTIONS(SECTIONS)

RTS.K=RT.K*5 48. A
RTS - REGULAR TEACHER SECTIONS(SECTIONS)
RT - REGULAR TEACHERS(TEACHERS)

RR.KL=RT.K*RN*RRM.K 49. R
RR - RETIREMENT RATE(TEACHERS/YEAR)
RT - REGULAR TEACHERS(TEACHERS)
RN - RETIREMENTS NORMAL(FRACTION/YEAR)
RRM - RETIREMENT RATE MULTIPLIER(DIMENSIONLESS)

RRM.K=CLIP(1,RTS.K/TS.K,TS.K,RTS.K) 50. A
RN=.05 50.1, C
RRM - RETIREMENT RATE MULTIPLIER(DIMENSIONLESS)
RTS - REGULAR TEACHER SECTIONS(SECTIONS)
TS - TOTAL SECTIONS(SECTIONS)
RN - RETIREMENTS NORMAL(FRACTION/YEAR)

NON REGULAR TEACHERS

NRTS.K=MAX(0,(TS.K-RTS.K)) 51. A
NRTS - NON REGULAR TEACHING SECTIONS(SECTIONS)
TS - TOTAL SECTIONS(SECTIONS)
RTS - REGULAR TEACHER SECTIONS(SECTIONS)

NRT.K=NRTS.K*V 52. A
V=1 52.1, C
NRT - NON REGULAR TEACHERS(TEACHER)
NRTS - NON REGULAR TEACHING SECTIONS(SECTIONS)
V - SECTIONS PER NON REGULAR TEACHER(SECTIONS/
NRT)

NON TEACHING REGULARS

NTR.K=TABHL(NTRMT,RT.K/RTN,.5,1.5,.1)*5 53. A
 RTN=72 53.1, C
 NTRMT=.5/.5/.5/.7/1/1/1/1.2/1.2/1.2/1.2 53.2, T
 NTR - NON TEACHING REGULAR(NTR)
 NTRMT - NON TEACHING REGULAR MULTIPLIER TABLE
 RT - REGULAR TEACHERS(TEACHERS)
 RTN - REGULAR TEACHERS NORMAL(TEACHERS)

SALARY COMPUTATIONS

RTSA.K=RT.K*W 54. A
 W=16387 54.1, C
 RTSA - REGULAR TEACHER SALARY(DOLLARS)
 RT - REGULAR TEACHERS(TEACHERS)
 W - RT SALARY(DOLLARS/RT)

NRTSA.K=NRT.K*Z 55. A
 Z=648 55.1, C
 NRTSA - NONREGULAR TEACHER SALARY(DOLLARS)
 NRT - NON REGULAR TEACHERS(TEACHER)
 Z - NRT SALARY(DOLLARS/NRT)

NTRSA.K=NTR.K*Y 56. A
 Y=20431 56.1, C
 NTRSA - NONTEACHING REGULAR SALARY(DOLLARS)
 NTR - NON TEACHING REGULAR(NTR)
 Y - NTR SALARY(DOLLARS/NTR)

CERTS.K=(RTSA.K+NRTSA.K+NTRSA.K)*II.K 57. A
 CERTS - CERTIFICATED SALARIES(DOLLARS)
 RTSA - REGULAR TEACHER SALARY(DOLLARS)
 NRTSA - NONREGULAR TEACHER SALARY(DOLLARS)
 NTRSA - NONTEACHING REGULAR SALARY(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

II.K=EXP(TIME.K*LOGN(1+D)) 58. A
 D=.08 58.1, C
 II - INFLATION FACTOR(DIMENSIONLESS)
 TIME - TIME(YEARS)
 D - CONSTANT ANNUAL INFLATION(FRACTION/YEAR)

CLASSIFIED SALARIES

CLS.K=CLSM.K*II.K 59. A
 CLS - CLASSIFIED SALARIES(DOLLARS)
 CLSM - CLASSIFIED SALARIES MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

CLSM.K=TABHL(CLSMT,WSCH.K,3E4,66E3,4E3) 60. A
 CLSMT=278E3/302E3/315E3/319E3/328E3/334E3/346E3/ 60.1, T
 359E3/372E3/45E4
 CLSM - CLASSIFIED SALARIES MULTIPLIER(DOLLARS)
 CLSMT - CLASSIFIED SALARIES TABLE
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

EMPLOYEE BENEFITS

EB.K=EBM.K*II.K 61. A
 EB - EMPLOYEE BENEFITS(DOLLARS)
 EBM - EMPLOYEE BENEFITS MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

EBM.K=TABHL(EBMT,WSCH.K,3E4,66E3,4E3) 62. A
 EBMT=62558/68941/69895/69823/89024/93892/103552/ 62.1. T
 110050/116548/12304
 EBM - EMPLOYEE BENEFITS MULTIPLIER(DOLLARS)
 EBMT - EMPLOYEE BENEFITS TABLE
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

BOOKS SUPPLIES AND EQUIPMENT REPLACEMENT

BSE.K=BSEM.K*II.K 63. A
 BSE - BOOKS SUPPLIES AND EQUIPMENT(DOLLARS)
 BSEM - BOOKS SUPPLIES AND EQUIPMENT
 MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

BSEM.K=TABHL(BSEMT,WSCH.K,3E4,66E3,4E3) 64. A
 BSEMT=78606/105839/101185/109672/124317/104322/ 64.1. T
 81744/87044/92343/97
 BSEM - BOOKS SUPPLIES AND EQUIPMENT
 MULTIPLIER(DOLLARS)
 BSEMT - BOOKS SUPPLIES AND EQUIPMENT MULTIPLIER
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

OTHER OPERATING EXPENSES AND SERVICES

OOS.K=OOSM.K*II.K 65. A
 OOS - OTHER OPERATING EXPENSES AND
 SERVICES(DOLLARS)
 OOSM - OTHER OPERATING EXPENSES AND SERVICES
 MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

OOSM.K=TABHL(OOSMT,WSCH.K,3E4,66E3,4E3) 66. A
 OOSMT=111E3/138E3/131E3/135E3/165E3/165E3/165E3/ 66.1. T
 182E3/199E3/215E3
 OOSM - OTHER OPERATING EXPENSES AND SERVICES
 MULTIPLIER(DOLLARS)
 OOSMT - OTHER OPERATING EXPENSES AND SERVICES TABLE
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

CAPITAL OUTLAY

CO.K=COM.K*II.K 67. A
 CO - CAPITAL OUTLAY (DOLLARS)
 COM - CAPITAL OUTLAY MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

COM.K=TABHL(COMT,WSCH,K,3E4,66E3,4E3) 68. A
 CCMT=48641/77530/96702/55313/26949/38813/59266/ 68.1, T
 59304/59341/59767
 COM - CAPITAL OUTLAY MULTIPLIER(DOLLARS)
 COMT - CAPITAL OUTLAY MULTIPLIER TABLE
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

OTHER OUTGO

OOM.K=OOM.K*II.K 69. A
 OO - OTHER OUTGO
 OOM - OTHER OUTGO MULTIPLIER(DOLLARS)
 II - INFLATION FACTOR(DIMENSIONLESS)

OOM.K=TABHL(OOMT,WSCH,K,3E4,66E3,4E3) 70. A
 OOMT=1E5/12E4/13E4/14E4/15E4/169424/227381/209181/ 70.1, T
 207419/199835
 OOM - OTHER OUTGO MULTIPLIER(DOLLARS)
 OOMT - OTHER OUTGO MULTIPLIER TABLE
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

TOTAL COST

TC.K=CERTS.K+CLS.K+EB.K+BSE.K+OOES.K+CO.K+OO.K 71. A
 TC - TOTAL COST(DOLLARS)
 CERTS - CERTIFICATED SALARIES(DOLLARS)
 CLS - CLASSIFIED SALARIES(DOLLARS)
 EB - EMPLOYEE BENEFITS(DOLLARS)
 BSE - BOOKS SUPPLIES AND EQUIPMENT(DOLLARS)
 OOES - OTHER OPREATING EXPENSES AND
 SERVICES(DOLLARS)
 CO - CAPITAL OUTLAY (DOLLARS)
 OO - OTHER OUTGO

REVENUE SECTOR
STATE REVENUE

SR.K=MAX(0,S.K) 72. A
 SR - STATE REVENUE(DOLLARS)
 S - STATE REVENUE LEVEL(DOLLARS)

S.K=S.J+DT*(DR.JK) 73. L
 S=874E3 73.1, N
 S - STATE REVENUE LEVEL(DOLLARS)
 DR - RATE OF CHANGE(DOLLARS/YEAR)

DR.KL=CLIP(AA.K,BB.K,ADA.K,3001) 74. R
 DR - RATE OF CHANGE(DOLLARS/YEAR)
 AA - TOTAL APPORTIONMENT FOR LARGE
 DISTRICT(DOLLARS)
 BB - TOTAL APPORTIONMENT FOR SMALL
 DISTRICT(DOLLARS)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)

AA.K=CLIP(P.K,Q.K,ADA.K,ADDA.K) 75. A
 AA - TOTAL APPORTIONMENT FOR LARGE DISTRICT(DOLLARS)
 P - APPORTIONMENT FOR LARGE DISTRICT WITH INCREASE IN ADA(DOLLARS)
 Q - APPORTIONMENT FOR LARGE DISTRICT WITH DECREASE IN ADA(DOLLARS)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)
 ADDA - PRIOR YEAR ADA(ADA)

ADDA.K=SMOOTH(ADA.K,1) 76. A
 ADDA - PRIOR YEAR ADA(ADA)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)

P.K=A.K+B.K 77. A
 P - APPORTIONMENT FOR LARGE DISTRICT WITH INCREASE IN ADA(DOLLARS)
 A - INCREASE OVER PRIOR YEAR LEVEL(DOLLARS)
 B - INCREASE DUE TO INCREASE IN ADA(DOLLARS)

A.K=SRR.K*I*EFM.K 78. A
 A - INCREASE OVER PRIOR YEAR LEVEL(DOLLARS)
 SRR - STATE REVENUE FOR PRIOR YEAR(DOLLARS)
 I - STATE INFLATION FACTOR(FRACTION/YEAR)
 EFM - EQUALIZATION FACTOR MULTIPLIER(DIMENSIONLESS)

SRR.K=SMOOTH(SR.K,1) 79. A
 I=.06 79.1. C
 SRR - STATE REVENUE FOR PRIOR YEAR(DOLLARS)
 SR - STATE REVENUE(DOLLARS)
 I - STATE INFLATION FACTOR(FRACTION/YEAR)

EFM.K=TABHL(EFMT,TIME.K,0,20,2) 80. A
 EFMT=1.09/1.1/1.11/1.12/1.13/1.14/1.15/1.16/1.17/ 80.1. T
 1.19/1.2
 EFM - EQUALIZATION FACTOR MULTIPLIER(DIMENSIONLESS)
 EFMT - EQUALIZATION FACTOR MULTIPLIER TABLE
 TIME - TIME(YEARS)

B.K=C.K*J*(1+I)*EFM.K 81. A
 B - INCREASE DUE TO INCREASE IN ADA(DOLLARS)
 C - CHANGE IN ADA FROM PRIOR YEAR(ADA)
 J - STATE AID PER ADA(DOLLARS)
 I - STATE INFLATION FACTOR(FRACTION/YEAR)
 EFM - EQUALIZATION FACTOR MULTIPLIER(DIMENSIONLESS)

C.K=ADA.K-ADDA.K 82. A
 J=589 82.1. C
 C - CHANGE IN ADA FROM PRIOR YEAR(ADA)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)
 ADDA - PRIOR YEAR ADA(ADA)
 J - STATE AID PER ADA(DOLLARS)

$Q.K = G.K + H.K$ 83. A
 Q - APPORTIONMENT FOR LARGE DISTRICT WITH DECREASE IN ADA(DOLLARS)
 G - DECREASE IN REVENUE DUE TO CHANGE IN ADA(DOLLARS)
 H - CHANGE IN REVENUE OVER PRIOR YEARS LEVEL(DOLLARS)

$G.K = J.C.K$ 84. A
 G - DECREASE IN REVENUE DUE TO CHANGE IN ADA(DOLLARS)
 J - STATE AID PER ADA(DOLLARS)
 C - CHANGE IN ADA FROM PRIOR YEAR(ADA)

$H.K = (SRR.K + G.K) * I.EFM.K$ 85. A
 H - CHANGE IN REVENUE OVER PRIOR YEARS LEVEL(DOLLARS)
 SRR - STATE REVENUE FOR PRIOR YEAR(DOLLARS)
 G - DECREASE IN REVENUE DUE TO CHANGE IN ADA(DOLLARS)
 I - STATE INFLATION FACTOR(FRACTION/YEAR)
 EFM - EQUALIZATION FACTOR MULTIPLIER(DIMENSIONLESS)

$BB.K = CLIP(PP.K, QQ.K, ADA.K, ADDA.K)$ 86. A
 BB - TOTAL APPORTIONMENT FOR SMALL DISTRICT(DOLLARS)
 PP - APPORTIONMENT FOR SMALL DISTRICT WITH INCREASE IN ADA(DOLLARS)
 QQ - APPORTIONMENT FOR SMALL DISTRICT WITH DECREASE IN ADA(DOLLARS)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)
 ADDA - PRIOR YEAR ADA(ADA)

$PP.K = P.K * (SDM.K)$ 87. A
 PP - APPORTIONMENT FOR SMALL DISTRICT WITH INCREASE IN ADA(DOLLARS)
 P - APPORTIONMENT FOR LARGE DISTRICT WITH INCREASE IN ADA(DOLLARS)
 SDM - SMALL DISTRICT MULTIPLIER(DIMENSIONLESS)

$QQ.K = CLIP(Q.K, QQQ.K, Q.K, QQQ.K)$ 88. A
 QQ - APPORTIONMENT FOR SMALL DISTRICT WITH DECREASE IN ADA(DOLLARS)
 Q - APPORTIONMENT FOR LARGE DISTRICT WITH DECREASE IN ADA(DOLLARS)
 QQQ - APPORTIONMENT FOR SMALL DISTRICT WITH DECREASE USING SDM(DOLLARS)

$QQQ.K = (SRR.K * I * EFM.K * SDM.K) + (C.K * J * (1 + I) * EFM.K * SDM.K)$ 89. A
 SRR - APPORTIONMENT FOR SMALL DISTRICT WITH
 DECREASE USING SDM(DOLLARS)
 SRR - STATE REVENUE FOR PRIOR YEAR(DOLLARS)
 I - STATE INFLATION FACTOR(FRACTION/YEAR)
 EFM - EQUALIZATION FACTOR
 MULTIPLIER(DIMENSIONLESS)
 SDM - SMALL DISTRICT MULTIPLIER(DIMENSIONLESS)
 C - CHANGE IN ADA FROM PRIOR YEAR(ADA)
 J - STATE AID PER ADA(DOLLARS)

$SDM.K = 1 / (.47615 + (.1746E-3) * ADA.K)$ 90. A
 SDM - SMALL DISTRICT MULTIPLIER(DIMENSIONLESS)
 ADA - AVERAGE DAILY ATTENDANCE(ADA)

FEDERAL REVENUE

$FR.K = M * (1 + NOISE()) * .5$ 91. A
 $M = 277E3$ 91.1. C
 FR - FEDERAL REVENUE(DOLLARS)
 M - FR CONSTANT(DOLLARS)

LOCAL REVENUE

$LR.K = TC.K - (SR.K + FR.K)$ 92. A
 LR - LOCAL REVENUE(DOLLARS)
 TC - TOTAL COST(DOLLARS)
 SR - STATE REVENUE(DOLLARS)
 FR - FEDERAL REVENUE(DOLLARS)

TOTAL REVENUE

$TR.K = SR.K + FR.K + LR.K$ 93. A
 TR - TOTAL REVENUE(DOLLARS)
 SR - STATE REVENUE(DOLLARS)
 FR - FEDERAL REVENUE(DOLLARS)
 LR - LOCAL REVENUE(DOLLARS)

TUITION

$T.K = \text{MAX}(0, \text{DISC.K}) / \text{WSCH.K}$ 94. A
 T - TUITION(DOLLARS/WSCH)
 DISC - DISCREPANCY(DOLLARS)
 WSCH - WEEKLY STUDENT CONTACT HOURS(WSCH)

$\text{DISC.K} = TC.K - TR.K$ 95. A
 DISC - DISCREPANCY(DOLLARS)
 TC - TOTAL COST(DOLLARS)
 TR - TOTAL REVENUE(DOLLARS)

CONTROL CARDS

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PRINT  T,LFS,MFS,UFS,LPS,MPS,UPS                      95.4
      T      - TUITION(DOLLARS/WSCH)
      LFS     - LOW INCOME FULL TIME STUDENTS(FROM 0-7999
                FAMILY INCOME)
      MFS     - MIDDLE INCOME FULL TIME STUDENTS(FROM 8000-
                24999 FAMILY INCOME)
      UFS     - UPPER INCOME FULL TIME STUDENTS(ABOVE 25000
                FAMILY INCOME)
      LPS     - LOW INCOME PART TIME STUDENTS(FROM 0-7999
                FAMILY INCOME)
      MPS     - MIDDLE INCOME PART TIME STUDENTS(FROM 8000-
                24999 FAMILY INCOME)
      UPS     - UPPER INCOME PART TIME STUDENTS(ABOVE 25000
                FAMILY INCOME)

PRINT  RT,NRT,NTR,SR,FR,LR,CERTS                      95.5
      RT      - REGULAR TEACHERS(TEACHERS)
      NRT     - NON REGULAR TEACHERS(TEACHER)
      NTR     - NON TEACHING REGULAR(NTR)
      SR      - STATE REVENUE(DOLLARS)
      FR      - FEDERAL REVENUE(DOLLARS)
      LR      - LOCAL REVENUE(DOLLARS)
      CERTS   - CERTIFICATED SALARIES(DOLLARS)

PLOT   T=T/TFS=F,TPS=P/RT=R,NRT=N/SR=S,FR=F,LR=L/    95.6
      CERTS=1
      T      - TUITION(DOLLARS/WSCH)
      TFS     - TOTAL FULL TIME STUDENTS(STUDENTS)
      TPS     - TOTAL PART TIME STUDENTS(STUDENTS)
      RT      - REGULAR TEACHERS(TEACHERS)
      NRT     - NON REGULAR TEACHERS(TEACHER)
      SR      - STATE REVENUE(DOLLARS)
      FR      - FEDERAL REVENUE(DOLLARS)
      LR      - LOCAL REVENUE(DOLLARS)
      CERTS   - CERTIFICATED SALARIES(DOLLARS)

SPEC   DT=1/LENGTH=20/PRTPER=.2/PLTPER=.2           95.7
      PRTPER - PRINT PERIOD
      PLTPER - PLOT PERIOD

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UNIVERSITY OF CALIF.
LOS ANGELES

OCT 0 1978

CLEARINGHOUSE FOR
JUNIOR COLLEGES